ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 180 No. 4686 LONDON, FRIDAY, NOVEMBER 18, 1955

UNIVERSITY OF MICHIGAN

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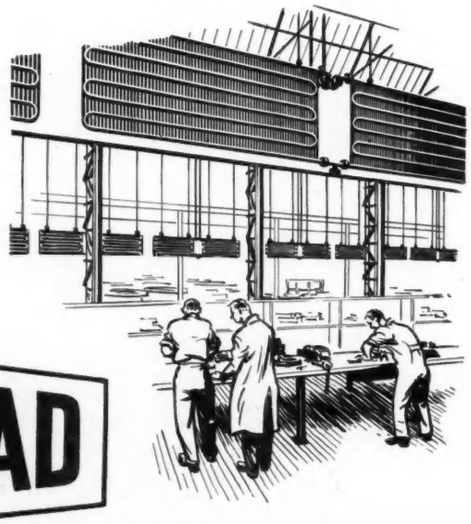

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Vol. 180 No. 4686 NOVEMBER 18, 1955

Leading Article
Exporting for Dollars 681

Weekly Survey
F.B.I. on Wage Costs 682
Two Wheels Better 682
There's no Stopping Plastics 682
Steel, Coal and Ships 682
Too Much or Not Enough Water? 682
Electra Airliner 683
Expanding Motor Industry is Sensitive 683
Ashes Regained 683
Reorganisation at de Havillands 683

Principal Articles
A "Kinsey" Survey of Engineers? 684
Aluminium in Shipbuilding: Design Study for River Tanker 684
Preventive Maintenance and Running Repairs 688
Effect of Turbine Engines on Aircraft Design: Factors which may Influence Future Trends 691
Managers Peer into the Future: Effect of New Methods and Materials on Industrial Growth 694
Films as an Aid to Management: Productivity and Sales from an American Viewpoint 695
Phosphorus and Melting Furnaces: Report of Cast Iron Research Association 695
The Iron and Steel Institute: Steelmaking and Steelworks Maintenance 696
The Diesel Engine of the Future: Long Service with Low Running and Maintenance Costs 698
The Professional Engineer and His Employer: Union Type Bodies in Britain and U.S.A. 699
Natural Gas: Exploitation in Italy, Exploration in England 700
Measuring Small Diameters with Precision: Fine Wires to Within 0·000 01 in. 703
Steel Fabrication: A New Factory at Crayford 705
75ton Breakdown Crane: Steam-Propelled Sets for Indian Broad-gauge Railways 706
Production of Lagging: Slabs and Preformed Shapes Made from Asbestos 708

Letters to the Editor
Is Hardy's Boundary Lubrication a Myth? 685

Obituary
Major C. E. Williams, C.B.E. 687
Mr. H. C. Makepeace 687

Book Reviews
"Up Funnel, Down Screw!" 689
Electromagnetic Principles of the Dynamo 689
Education and Training for Industrial Management 689

Notes
Concrete Quality Control 684
Dollars for Machinery: Exports Drive Renewed 685
Wakefield Scholarships 685
Machinery for Oil Wells 687
Steam and Steamships 687
Gas-Turbine Courses 695
Fracturing the Safety Diaphragm of a Steam Turbine 696
Resin Adhesive and Casting Material 696
Ex-Service Equipment for Weather Forecasting 699
Microphone for Dusty Atmospheres 704
Flameproof Flash Equipment 705
Lubrication of Crane Rails 707
Automatic Control for Helicopters 709
Rotary Surface Grinder 709

In Parliament 710

The Human Element 712

Personal 686, Commercial, 686, Contracts 686, Launches and Trial Trips 688, Books Received 690, Trade Publications 690, Notices of Meetings 711

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Published every Friday by Engineering Limited 35 & 36 Bedford Street, Strand, London, W.C.2 TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663

Subscription Rates for 12 months, Inland and Abroad £5 10s., Canada £5 5s. Subscriptions for periods of less than 12 months are based on the price of a single copy including postage [2s. 3d.]

EXPORTING FOR DOLLARS

THE story of the trade between dollar account countries and the rest of the world told by the Dollar Exports Council to the Press last week was full of interest and is worth careful consideration. The angle was new: not, as in the days of Sir Stafford Cripps, "the country needs dollars, you must earn them," but "see for yourselves the opportunities that are before you." Statistically the opportunities look quite good (the figures are given on page 685). Sir William Rootes, chairman of the Dollar Exports Council and of Rootes Limited, thinks that they are good, and so does Mr. A. R. T. Low, Minister of State at the Board of Trade, who said: "The great importance of these markets is the great opportunities which they offer, by virtue of their size and wealth, and their promise of future expansion, for the establishment of enduring and profitable business." But many of our readers could rightly say that they remember failures in those very markets, when a large number of companies tried at Sir Stafford's request. What has changed to-day that there should be more opportunities for enduring trade?

There are three answers to this question. The first is that some who tried then are now well established. The second, that the imports of those countries have expanded greatly, by 60 per cent. in value and at least one-third in volume. The third answer concerns Britain's balance of payments. Rising industrial production must be sustained by increased imports of materials or it will stop rising and may decline. The proportion of exports must rise to pay for imports, and we can expect to be helped far less than we have been. In nature, the position is the same as in 1949; in degree the problem is a much bigger one. It may well be that the dollar account countries offer as good or better opportunities for a permanent increase in our exports than the rest of the world. They can certainly not be dismissed out of hand as hopeless markets. It may be therefore that in driving hard for the dollar markets British manufacturers will combine self-interest with national interest. Presumably those were the considerations which led the eighty industrialists, bankers and merchants who also met the Dollar Exports Council and Government representatives last week to pledge their active support to the Council.

The other questions that arise are more precise and tend to be harder to answer in general terms. What should be marketed, how should it be sold, and in what markets? An analysis of the imports of the countries concerned will show what products are currently being successfully sold to them, and by whom as well as, approximately, for how much. In general, in the United States they are products which are not made in very large quantities and for which production costs are high since scale is not available. They tend therefore to be products where a high proportion of total costs are labour costs, such as ships and electrical machinery. In addition there are the products which are typically British, or European, in design and styling and are bought mainly for that reason, such as sports cars and small "shopping cars," bicycles and motor cycles. Since the U.S. is the principal exporter to other dollar account countries the same types of goods are likely to succeed there as in the U.S., although self-interest (to provide a basis for a two-way trade), or a reluctance to depend entirely on the U.S., or even sentiment in some cases, will tip the scales if otherwise finely balanced. There is no better guide to a would-be exporter than the trade statistics of the countries concerned or those published by the exporting countries. In the case of the U.S., and to some extent of Canada also, engineering components are sometimes in vigorous, if marginal, demand and the attempt to break into these markets should not therefore be confined to finished products.

Even if a manufacturer finds his products are in good demand, they still have to be sold. The best way to begin is probably in a small way in a favourable market such as western Canada, where pro-British feeling is strong and to which shipping costs are relatively low. Another good place to begin is Panama. A thorough knowledge of the area, personal representation and familiarity with the detailed requirements of the market are essentials. If successful, it should then be possible to expand into neighbouring markets, having taken the measure of U.S. and local competition. There are, of course other ways in, some more direct, but few are open to the medium and small company. Joint ventures with local industrialists in setting up assembly or manufacturing facilities are favoured by some, particularly in the Caribbean countries. Joint selling by several non-competitive companies is cheaper and has been done successfully with electrical machinery, small tools and instruments.

The D.E.C. have representatives in all principal trade centres in the dollar area. British trade commissioners are available in most large towns (two of the seven in Canada specialise in engineering products) and commercial services exist at Consular posts. The Treasury are willing to allocate dollars for any worth-while venture and the Export Credits Guarantee Department offers insurance. But there are no subsidies of any kind. The major effort and expense, and therefore the choice, is industry's.

Weekly Survey

Cover Picture: *A co-ordinatograph is used for examining and measuring air-survey photographs. The photograph under observation is carried on a table mounted on a slide traversing the whole Y axis; the X traverse is obtained with a microscope fitted on a sliding carriage mounted at right-angles to the Y traverse slide. Readings can be taken to* 0·01 *mm. in either ordinate.*

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F.B.I. on Wage Costs

Like the Primate of all England the Federation of British Industries has at times to steer a delicate course between what it thinks is right and what may be the official view of the Government. Its recent pronouncement on the present economic position is a case in point. Unlike the T.U.C. it cannot either by inclination or tradition enjoy the luxury of outspokenly rude comment on the Chancellor of the Exchequer's recent Budget. The T.U.C. could be somewhat brusquely disapproving in its views of the new fiscal measures after it had visited the Chancellor; when the turn of the F.B.I. came to make the same journey its reactions had to be a good deal more circumspect.

The Federation is in agreement with the Government on the cause of the present instability and it agrees that it was necessary for the Chancellor to restrict credit and to reduce Government and local authority capital expenditure. It supports the Chancellor's request that individual companies should review their own capital programmes and postpone such items as are not immediately needed for the export drive. On the other hand, the Federation would have preferred to see the Government reduce its expenditure rather than increase purchase tax, and it is strongly of the opinion that the increase in profits tax cannot have a noticeable effect on the attack on inflation. The most serious problem now, in the view of the F.B.I., is the threat of widespread claims for large wage increases. The Federation has asked all members to refrain from price increases wherever the level of costs leaves the choice open in determining selling prices.

There is clearly quite a good deal of difference between the Federation's views and those of the Government, but the statement shows little awareness of how to face up to the political as well as to the economic problems which have faced the Chancellor in recent months. None of his critics yet has produced a formula which will show how to administer more than a very mild dose of deflation without seriously dismantling what the electorate considers an important section of the Welfare State. At least, however, the F.B.I. has thrown a very considerable weight on the side of public responsibility and constructive policy.

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Two Wheels Better

The various mutations of the two-wheeled vehicle which have made their appearance on the Continent since the war have become familiar on British roads; but until this year few British companies had entered the field on any considerable scale. At this year's Cycle and Motor Cycle Show there are for the first time a large number of British motor scooters and "mopeds" on show and there can be little doubt that they compare favourably with their Continental equivalents.

The Vespa and Lambretta have already made the motor scooter well known in this country, but the moped or motorised pedal cycle has only comparatively recently, with the advent of the N.S.U. "Quickly" and certain other German machines, secured favour. The moped lies somewhere between the ordinary pedal cycle and the motor cycle, and its engine, unlike the clip-on motors widely used in recent years, is not an afterthought but an integral part of the design. It has in general a front wheel fitted with pivot-arm springing, a pressed-steel structure with built-in petrol tank, considerable carrier and pannier space and extensive metal fairing. The cylinder capacity is usually about 50 c.c., the fuel consumption 200 miles per gallon and the top speed approximately 40 m.p.h. The autocycle, or bicycle plus fitted power unit, has suffered an eclipse owing to the imposition of a rate of purchase tax on clip-on engines equal to that for complete motor cycles and to the consequent rise in the minimum permissible hire-purchase deposit.

Examples of new British mopeds on display are the Mercury "Mercette," which has a four-stroke engine and is built to take a passenger; the Power-Pak "Moped," which is a clutchless machine having a combined throttle and engine decompressor twist grip; and the B.S.A. "Dandy 70," which incorporates front and rear wheel springing and two-speed pre-selector with handle-bar control. The prices of mopeds range roughly from £60 to £80 including purchase tax. In addition, J. A. Prestwich Industries, Limited, announce that a new J.A.P. 49 c.c. engine is being made for the moped market.

Motor scooters vary in engine capacity from the 48 c.c. Britax "Scooterette" and Mercury "Hermes," to the 225 c.c. Dayton "Albatross," which is capable of 65 m.p.h. and cruises at 50 m.p.h. Of special note is the new 198 c.c. B.S.A. "Beeza," which has a four-stroke engine, electric starter, shaft drive, four-speed gearbox and full springing, front and rear. Also of interest is the 6 volt pre-engaged starter motor which Joseph Lucas Limited are making for scooters. Scooters range in price from about £80 to over £200.

If the already well supported scooter clubs are any indication, and if petrol prices remain at their present high level, it is not unlikely that the entry of British manufacturers into the moped and scooter market will mean an increasing use in Britain of these forms of locomotion for purposes ranging from shopping excursions and casual travel to holidays and sport. In that case, and if popularity is a fair measure of value then—to misquote George Orwell—there will be many supporters of the dictum "four wheels good but two wheels better."

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There's No Stopping Plastics

The sale of plastics materials in Western Europe has made big advances in the last few years. Some interesting figures have been put out by the Organisation for European Economic Co-operation showing the sale of plastics in 1950, 1953 and 1954. The two outstanding features over those years have been the general increase in sales, remarkable in the case of thermoplastics.

Between 1950 and 1954 the sale of thermoplastic materials (including polythene, polyvinyl chloride, polystyrene and acrylic) has gone up more than four times, from 85,482 metric tons to 369,421 metric tons. It seems probable that much of this expansion is due to the growing competitive power of polyvinyl chloride in the fabrics field. P.V.C. has also, of course, made some inroads in tubes against special steels. Within the group, certain injection moulding techniques have made big strides in mass production of popular products made from polythene. In polythene there have been big advances in industrial uses (of which coverings for cables are an example) and in the packaging field.

Compared with the remarkable increase in sales of thermoplastics, the expansion in the sale of thermosetting plastics (including phenolic and amino plastics and alkyds) looks almost pedestrian. But it is substantial. Between 1950 and 1954 the sale of thermosetting resins went up from 204,620 metric tons to 368,459 metric tons, that is by 89 per cent. This rate reflects the state of progress of the older compression moulding techniques and the steady, rather than phenomenal, expansion in technical progress. There is, of course, a good deal of competition with metals from this group, and if the growth of thermosetting plastics should seem to be dwarfed by the performance of the thermoplastic group it is worth recalling that between 1950 and 1954 this expansion of 89 per cent. for sales compares very favourably with the output of steel in Western Europe, which has gone up, under continuing boom conditions, by only 28 per cent. while comparison with copper is even more favourable.

There has been a useful increase in the sale of cellulose derivatives and among hardened casein products, which have gone up between 1950 and 1954 by 43 per cent. and 34 per cent. respectively. Altogether, after the setback in plastic developments in the late 1940's (which followed a rather indiscreet plastics mania at the end of the war) the industry has forged ahead both in developing new uses for its products and in offering intensified competition to the more traditional materials both in consumer goods and in industrial products.

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Steel, Coal and Ships

The high steel output figures for October recently announced by the Iron and Steel Board mask only very faintly the continuing shortage of steel. Although the average weekly figure for last month of 399,500 tons represents a 6 per cent. increase in annual rate on last year's October output, and averages 1,700 tons a week more than in September this year, order books on the whole are still full to about six months ahead.

That this figure continues to be a long way short of the needs of the metal-using industries is clearly shown in the official statistics. A 10 per cent. increase in output of metal manufactures is said to require a 9 per cent. increase in the output of steel and, going on this 10 : 9 proportion, the 12 per cent increase in the output of metal manufactures during the first six months of the year should require a 10·8 per cent. rise in steel production. Domestic steel output over the first ten months of this year has in fact risen by about 6·3 per cent., and the discrepancy has had to a large extent to be met by extensive imports of steel. During the first eight months of 1955 imports of finished steel averaged 68,250 tons a month, compared with 20,700 tons twelve months earlier, and are likely to increase. Meanwhile stocks of ingots and semi-finished steel held by producers have risen by some 400,000 tons since the beginning of the year, which suggests a bottleneck building up in places in finished steel capacity. In view of the predicted record output for the last quarter of the year, and the fact that November is usually the peak steel production month, it will be interesting to see if these stocks can be reduced in "bull" months with existing capacity. However, as the Iron and Steel Board pointed out a few weeks ago (ENGINEERING, October 21, page 555), there is a strong possibility that imports of steel may be endangered during the winter. The sharp increase in coal imports, which are unlikely to decline, may take up shipping tonnage that might otherwise be used for steel and pig iron.

While the raw material situation has improved (stocks of pig iron had recovered by October 1 to 831,000 tons compared with the low figure of 579,000 tons reached after the rail strike), the industry still relies heavily upon imported ores for its steel production, and competition for cargo space between coal on the one hand, and iron and steel on the other, may endanger the raw material situation this winter.

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Too Much or not Enough Water?

The drought which commenced in midsummer has created serious water shortages on the flanks of the Pennines in the County of Durham, in Wakefield, Carlisle, Tees Valley, Chesterfield, the Irwell Valley and in numerous small towns in the north of England and Scotland. The situation became so grave in Wakefield and Durham that supplies through the domestic tap

in many districts ceased, the consumers being forced to collect their supplies from standpipes in the streets. The rainfall in the north has been extremely low in the four consecutive months of July, August, September and October, but it in no way constitutes a record drought parallel with those of 1854, 1887 or 1921. The afflicted undertakings, deriving their water from upland resources where the reservoir levels have fallen to dangerous levels, have been in increasing potential danger for several years, because water demands have exceeded the available dry weather resources.

New housing developments on a vast scale, the improvement of hot-water facilities in older property, full employment, the great surge in water demand from industry now at peak production, have collectively raised water demands to exceed the available dry weather resources. During the drought, as in all droughts, water requirments were further inflated by still higher demands by all consumers, and this has been sufficient to make the serious breach into the dry weather reserves. Public water supply is a virtual monopoly, but is restrained by statute from the economic law of supply, demand and price. In water supply, maximum price is determined by the Minister of Housing and Local Government, after he has listened to all objections at the necessary inquiry. Inevitably the price of water always lags behind other price movements and is unrelated to supply and demand.

At Wakefield a new concrete dam of attractive appearance is now approaching completion. When this additional storage becomes available, then Wakefield will undoubtedly be happy for some years. Unfortunately, in British water supply the gap between the proposal of a new project and its completion is a much more protracted period now than before the war.

Despite these difficulties and the severe competition for engineering skill, the water industry has provided much more water than ever before. The real danger is that demand, especially for industrial purposes, may continue to outstrip the present development of new water resources, particularly as increased demand is encouraged by the rigidity of the statutory and traditional price mechanism, which too often provides water for the large industrial consumer well below cost. Thus Manchester, having completed the first aqueduct from Haweswater to the city, is already preparing for the construction of a second line. Many believe that the industrial demands for water supply are excessive, and the waste considerable, but its cost is relatively so low a fraction of industrial costs. It is a sad aspect of water supply history that only complete failure of supply brings home the fact that water is not only vital to public health, but also that its absence severely damages our economic well-being

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Electra Airliner

The latest progress report on the Electra airliner issued by the Lockheed Aircraft Corporation, Burbank, California, indicates that the design has now stabilised at a higher performance than originally quoted and that production planning is well under way—as, indeed, it must be if the promised delivery date of August, 1958, is to be fulfilled. The Electra, it may be recalled, is competitive with the recently announced Vickers 900 Vanguard in its long-range form. Vanguard deliveries, however, are not scheduled until 1960, which appears, on the face of it, to be a more realistic programme than that scheduled for the Electra.

Lockheed, however, are not inexperienced in the production of airliners. It may therefore be presumed that they have good grounds for their confidence. They have the advantage of being able to call upon the services of a number of other aviation firms to speed up their production. They have subcontracted the landing gear to the Menasco Manufacturing Company, Burbank; the tail to Northrop Aircraft Incorporated, Hawthorne; power plants to the Rohr Aircraft Corporation, Chula Vista; and flaps and ailerons to Temco Aircraft Corporation, Dallas, Texas. Nearly two-thirds of the wind tunnel tests have been completed, the fuselage and cockpit mock-ups are well under way, and factory space is being planned. Tooling is to start before the end of the year, and initial parts manufacture will start before next spring.

With full payload and fuel for an 1,850 mile flight against a 50 m.p.h. headwind, the Electra will be able to operate from airports with runways of only 1,620 yards. The maximum range with 66 passengers and reserve fuel for 2½ hours is 3,000 miles, at a cruising speed of 410 m.p.h.

The figures issued for the Vanguard by Vickers-Armstrongs, Limited, are less detailed, but it is said to be capable of development into an aircraft for 90 passengers over sector distances of 2,500 miles at a cruising speed of at least 400 m.p.h. When the new Rolls-Royce Tyne is developed, cruising speeds of 425 m.p.h. are expected. While it seems probable that the Tyne should give better economy than the Electra's Allison engines, it has to be remembered that the Electra has been designed with the possibility of installing other propeller turbines which may make it fully competitive with the Vanguard.

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Expanding Motor Industry is Sensitive

Commenting on the successful year which ended on July 31, 1955, Sir William Rootes, chairman of Rootes Motors Limited, has drawn attention once more to the need for the motor industry to keep down its internal costs by increasing volume of output and by giving every possible encouragement to increased productivity on the shop floor. Sir William drew attention to the continued pressure of materials costs on his own company's production. In the year he has reviewed in his statement accompanying the accounts, he has pointed out that the price of Rootes' products has been kept unchanged only by a reduction in the profit margin. Such is the consequence of the pressure of external factors like wage increases, higher coal, steel and transport prices and the higher cost of electrical power.

This year there has been a noticeable consensus of opinion in the motor vehicle industry on the need to offset the price of bought-in materials and labour by higher productivity within the industry's own factories. Profit margins are to be defended by higher output which will bring with it increasing opportunities for using to full capacity extensive and highly specialised machines. The industry's thinking is clearly conditioned by the need to press on with the economies of ever larger scale production. Higher productivity means greater output and greater output will in turn lead back to higher output per man.

It is not difficult to understand from this line of thinking how bitterly the industry resents any attempt to curtail the home market. It is equally clear that the motor car industry is likely to be in the forefront of any move towards automation.

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Ashes Regained

The rapid growth in the burning of pulverised coal in power stations is making available immense quantities of a relatively new material, pulverised fuel ash—p.f.a.—the annual output of which has risen from 750,000 tons in 1947 to about 2 million tons and may be expected to reach 4 million tons by 1960. At to-day's figures, it is costing the Central Electricity Authority about 5*s.* a ton to dig a hole and dispose of it, yet this material possesses many of the properties of the volcanic ashes, or pozzolanas, used by the Romans in combination with calcined limestone as a cementing material when they built such enduring monuments as the Colosseum and the Pantheon. Unlike natural pozzolanas, however, p.f.a. has the advantage of already being finally divided, so requiring no crushing or pre-treatment.

Under suitable conditions, four uses in building and civil engineering work appear to offer economic methods of using p.f.a.: mixed with clay to produce bricks; to replace part of the cement, or sand, in concrete generally; to make concrete building blocks; and, by sintering, to form a lightweight aggregate. Each of these processes has been thoroughly investigated at both the Leatherhead laboratory of the C.E.A. and at the Building Research Station, Garston. In addition, a considerable amount of industrial experience is being accumulated. Bricks are being made with ash from several power stations, including Hams Hall, Rye House and Brighton; p.f.a. concrete has a lower heat of hydration than normal Portland cement, develops an equal strength at three months, and is being used by the North of Scotland Hydro-Electric Board for some of their dams. The C.E.A. is laying roads with it; several contracting firms of national repute—for example, the Mitchell Engineering Group—are making blocks using p.f.a. and, with others, are considering making aggregates at power station sites.

Basic research work and experience at home and abroad have demonstrated the possibilities. The snags have been revealed, but they can be eliminated. The way is now clear for more extensive trials leading to commercial development. P.f.a. is available at a nominal price from the C.E.A. at widely distributed points throughout the country and the supply can be guaranteed for many years to come.

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Reorganisation at de Havillands

Equality like justice must not only exist but be seen to exist. The de Havilland group are putting their production units on a formally equal footing as from November 30. On that date a company meeting will take place to create de Havilland Holdings, Limited, which will become the holding company for all de Havilland enterprises at home or overseas. The three main operating subsidiaries in Britain will then be the de Havilland Aircraft Company Limited, the de Havilland Engine Company, Limited, and de Havilland Propellers Limited.

Until now the nominal parent company has been the aircraft company at Hatfield. During and since the war the other two main manufacturing centres have been growing rapidly and achieving maturity and parity with the aircraft section. Under the new arrangement these three producing entities will have equal status in the eyes of the controlling unit. It is never possible to ensure in any company that one division or section will not wield predominant influence at any one time. So much depends upon the state of technical development and the strength of personalities at any one time. Nevertheless it is desirable to establish a power and management organisation which will keep these inevitable problems to the minimum. Other companies, including aircraft companies, have had this kind of problem in the past and have used this particular technique of company organisation to overcome it. So far as de Havillands is concerned, the reorganisation is a useful tidying-up operation for a company which has grown over the last two decades.

Clarity of organisation is necessary to-day when an aircraft company makes a sustained bid for the world lead in civil aircraft development. The Comet has paid the price of being the pioneer in civil jet aviation, but ahead lies the intricate phasing of the performance of the Marks 2, 3 and 4. Full-scale fatigue tests are in hand on the Comet 2, which is an R.A.F. Transport Command version ; sections of the Comet 4 are being tested at the same time. The flight trials of the Comet 3 are making it possible to give accurate performance figures of the Comet 4 now to airline operators. To bring all this to fruition for the Comet 4 to lead the world will call for the highest standards of technical excellence and of business organisation.

A "KINSEY" SURVEY OF ENGINEERS?

One would not expect to find a reference to the surveys of sexual behaviour by Dr. A. C. Kinsey and others in a paper to the Institution of Mechanical Engineers. Yet it was there in the paper discussed at a meeting last Friday, and the author was Mr. P. P. Love. His experience as a director of the Glacier Metal Company, Limited (makers of plain bearings and bearing metals) has led him to conclude that engineers to-day are not being educated to apply fundamental knowledge. Though he criticised the pattern of education provided at universities and technical colleges, the point he wished to make was that a large-scale survey should be undertaken among engineers who have qualified in previous years. The survey would be conducted, like the Kinsey survey, by a team using questionnaires, and it would be designed to produce the data that, in his opinion, are essential if the education of engineers is to be studied and planned scientifically.

For the Kinsey reports, three investigators "interviewed 11,734 people for case histories *prima facie* as complex as envisaged in the questionnaire and certainly on a much more delicate subject." The average number of questions answered at each interview was 300, and the statistical problems involved in analysing the data are fully described in the reports. Mr. Love was not suggesting a solution to the perennial problem of the education of engineers but was suggesting how a solution might be found, "namely, as with the finding of solutions to problems in the industrial world, by research." Following this scientific approach, he said, conclusions would be reached which might well advance educational methods. The survey should be supported by the engineering institutions, and the money should come either by direct Parliamentary vote or by a grant from the Department of Scientific and Industrial Research; and if not from either of these then by a grant from industry. That the cost would not present any great difficulty was shown by the fact that a group of large industrial firms had recently promised £1,500,000 for helping scientific education in schools.

How was Mr. Love's proposal received? The discussion fluctuated from luke-warm support to forthright opposition, with a good measure of irrelevant comment. Wing Commander T. R. Cave-Browne-Cave was one of the few speakers to agree with Mr. Love's proposal for a scientific survey. He said it was important, in deciding what improvements should be made, to start with a careful analysis of what improvements were most necessary and could be introduced without too much upheaval. "I agree very much with the author," he said, "that there should be a careful investigation of what is necessary and of the order of importance. It should undoubtedly be done under the aegis of the major institutions." He was not sure, though, why the author was so anxious to bring in sociologists. (Mr. Love believes that engineers would not be the right people to carry out the survey because they would be the objects of the study and would have to display a rare measure of objectivity. He believes the research should be done by sociologists, with engineers and teachers of engineering subjects co-operating.)

ANALYTICAL APPROACH

Part of Mr. Love's paper was devoted to the observed performance of two hypothetical engineers, Mr. *A* and Mr. *B*, when faced with three representative design problems. Mr. *A* invariably adopted the obvious solution, whereas Mr. *B* studied the problems analytically and produced solutions which made fuller use of fundamental principles of engineering. Mr. Love believes that the universities and technical colleges could do more to educate engineers so that they think like Mr. *B*.

One of the speakers in the discussion, Mr. H. E. Dance, argued that this kind of problem-solving belonged to the later stages of an engineering education; traditionally it belonged to professional pupillage—that is, "problem-solving in a setting of engineering reality." "In short," he said, "this part of the business is a matter for both the college and the industry." Turning to the question of a survey he said that teachers would be glad of any information or guidance that might come from a research, but they would be unworthy of their profession if they did not exercise their judgments and fashion their teaching to make the best use of what they could teach and their particular lot of students could learn. But he agreed with Wing-Commander Cave-Browne-Cave that the research should not be handed over to sociologists. "In the meantime," he said, "let us not underestimate the thought and the effort that has been put into the problem by those who are tackling it at the side of their full-time jobs."

Dr. F. T. Barwell did not consider the indictment of the English universities to be quite fair. The college principal who stated that the scientific approach could not be taught but should "penetrate all teaching," was probably saying all that could be said on the topic. He suggested that Mr. Love was asking the universities to do something that industry must do for itself.

Mr. F. Bray said it was sometimes forgotten that they were educating people who would work in industry for another 40 years. They should therefore look at the problem in the light of how they could educate these people to enable them to learn for the next 40 years. He said he would first like to see a small committee set up to ascertain whether there was a *prima facie* case for research of the kind proposed by the author. The Ministry of Education, he said, would be glad to help.

The necessity for an inquiry was not accepted by Dr. D. Clayton. He believed that what was required was a raising of the standard of teaching fundamentals among those university schools and technical colleges which had not yet reached the required high standard.

The discussion ended like any other Institution meeting—it left people thinking but with no concrete proposal or rejection of action. That is normal and appropriate to a normal Institution paper, but when a paper—like Mr. Love's—proposes a new policy it might be more suitable for the meeting to be conducted in debate form, concluding with votes for and against. It would probably not have served to implement Mr. Love's proposal, but it would have helped to concentrate the discussion on the true significance of the paper. The proposed survey was the really significant feature, not "A Criticism of the Technical Education of Recently Qualified Engineers," which was the title of the paper.

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CONCRETE QUALITY CONTROL

A Technique of Accelerated Testing

A method of determining the expected seven- and 28-day strength of concrete before the site work has fully hardened (and possibly been buried by subsequent work) has been developed by Professor J. W. H. King, M.I.C.E., and his research assistant, Mr. N. G. Bondre. Briefly, the method proposes the accelerated hardening of the test cubes by drying them under standardised conditions in an oven held at a temperature slightly below that of boiling point for a period of 5 hours. The specimens can then be tested approximately seven hours after mixing, and an extensive investigation (over 2,000 tests) has shown that a high accuracy of prediction is obtained for many concretes.

Further details of the method, which has been evolved in response to a request from the Port of London Authority, are given in the November issue of the *Chartered Civil Engineer*. It is proposed to employ the method under site conditions on some construction work now being commenced by the Port of London Authority, but Professor King would be grateful for any reports on the technique from anyone interested to give the method a trial under site conditions using a wider variation of materials than has been possible hitherto. Fuller details can be obtained from him at Queen Mary College, London, E.1.

ALUMINIUM IN SHIPBUILDING

DESIGN STUDY FOR RIVER TANKER

The relative prices of steel and aluminium are such that it seems unlikely to be economic to use aluminium as a structural material in building ships. There are, however, certain special cases where the size of the ship is limited by external rather than design conditions, such as the Canadian lakes canaller, the bunkering lighter or small river tanker. In these cases the ship may have limits in overall dimensions, and the only way to increase the deadweight carrying capacity is to reduce the ship's hull weight. The shipowner must decide whether the increase in deadweight capacity is worth the increase in first cost. A study has been made in the use of aluminium in shipbuilding to increase the carrying capacity without increasing the total weight, and it was reported to the Institution of Engineers and Shipbuilders in Scotland in a paper entitled "An Aluminium River Tanker Design," given by Dr. E. C. B. Corlett, M.A., and Mr. K. J. Fryer on November 1, 1955.

The design for the aluminium ship was based on a steel construction bunkering lighter carrying 320 tons cargo deadweight in salt water on a draught of 8 ft., with overall length 139 ft. and breadth moulded 25 ft. 6 in. The hull was redesigned completely in aluminium alloy, but it was felt that the all-aluminium ship was an unrealistic pipe dream. Certain items would remain unchanged between the two designs: main machinery, windlass, hawse pipes, anchors and cables, bollards and fair-leads, pumps, and a number of other items. In the case of a number of items experience has already shown that aluminium alloy is satisfactory. Such items are cargo piping, bilge and ballast piping, ladders, davits, and funnel.

The results of the design study can best be seen in tabular form; all weights are given in tons.

—	Steel Design	Aluminium Design
Hull weight	150·24	72·79
Main machinery	9·73	9·73
Load :		
Fuel oil	16·00	14·00
Fresh water	5·00	10·00
Cargo	320·00	400·00
Crew and effects	0·44	0·44
Stores	3·00	3·00
Total	504·41	509·96

For a slight overall increase in weight an extra 80 tons of cargo can be carried. An approximate additional cost for the aluminium design is £14,000, or £175 per additional cargo ton; this compares with a cost of the steel ship per deadweight ton of £190 to £200.

The paper makes a good case for the aluminium construction under the given conditions, but stresses that although aluminium construction should be developed, the physical characteristics should be used to advantage.

DOLLARS FOR MACHINERY

Exports Drive Renewed

A new campaign is getting underway to persuade British manufacturers that it is worth having a shot at dollar markets. At a Press conference last week, called by the Dollar Exports Council, Sir William Rootes, the chairman, Mr. A. R. T. Low, Minister of State, Board of Trade, and Sir Edward Boyle, Economic Secretary to the Treasury, were unanimous in their emphasis that dollar account countries provide British manufacturers with " one of the great opportunities for the expansion of our trade." It is the subject of this week's leading article and the purpose of this note is to set out the facts.

First, an overall picture: there has been a considerable expansion in the imports of dollar countries during the past five years. In 1949, the U.S. imported 2,761 million dols. worth of goods; this has now risen to an annual rate of 10,826 million dols. so far this year, or nearly two-thirds more. The imports of Canada have risen from 2,761 million dols. to 4,419 million in the same period, and those of dollar Latin America countries from 2,313 million dols. to 3,427 million. The aggregate increase amounts to 60 per cent. by value and at least a third by volume. The British share of the total U.S. imports in the first eight months of this year was 5·3 per cent., that of Germany 2·8 per cent., and that of Japan 3·3 per cent. The United States accounted for 74·6 per cent. of total Canadian imports, our share being 8·3 per cent. and that of Germany 1·3 per cent. Dollar Latin America countries (14 countries, among which Venezuela, Colombia, Mexico and Panama are the most important) obtained 64·9 per cent. of their imports from the U.S., 4·6 per cent. from Britain and 5·7 per cent. from Germany. The meaning of these figures is clear enough: the amounts imported into the dollar countries are vast but our share is very small.

Next, the particular position of metals and engineering products: in 1954, Britain exported £40 million of metals (mainly steel tubes) and £107 million of engineering products to the dollar countries. Of these totals, £15 and £38 million respectively went to the U.S., £17 and £41 million to Canada and £8 and £28 million to dollar Latin America. So far this year, exports of engineering products to these countries were at the annual rate of £150 million. The amounts, though a small proportion of the countries' total imports, are substantial enough.

Finally, what type of products? It is difficult to enumerate without giving much space to statistics: all are available in the Trade and Navigation Accounts. Cars, cycles, electrical machinery and agricultural tractors were the major items, followed by textile machinery, scientific instruments, office machinery, ships and boats, Diesel engines, commercial vehicles, machine tools and some 10 other categories. The lowest export figure of the categories listed was at the rate of over £2½ million a year. A number of British engineering concerns are thus succeeding. The D.E.C.'s contention is that more could try with profit.

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MECHANICAL HANDLING ON TOUR

Demonstration Train

A demonstration of mechanical handling by fork trucks, platform trucks and tractors has been arranged by Lansing-Bagnall Limited, Kingsclere-road, Basingstoke, Hampshire, which is to be taken by special train, starting from London, to Bristol, Cardiff, Liverpool, Manchester, Glasgow, Newcastle, Leeds, Hull, Sheffield, Nottingham and Birmingham. The train consists of five wagons carrying the different trucks and tractors, which are electrically driven, and examples of the types of load each can handle, a cinema coach and a reception coach.

Letters to the Editor

IS HARDY'S BOUNDARY LUBRICATION A MYTH?

SIR, The desire to express surface wear and friction in terms of molecular forces has been apparent since Osborne Reynolds announced his classical theory of lubrication in 1886. It is now obvious that this desire was not supported by any direct evidence that molecular phenomena play an important part in friction, but arose simply from the unfortunate fact that Reynolds theory predicted that there should be no hydrodynamic lubrication in the case of the parallel slider. Rayleigh, Hardy, even Lamb, and many others, have accepted the Reynolds solution without question as something fundamental in hydrodynamics.

However, from the work of the present writer* it follows the that Reynolds theory of lubrication is an over-simplification of the Navier-Stokes dynamical equation from which it was derived. The correct approximate solution for the parallel slider is

$$\frac{h}{b} = \frac{3\eta U}{\pi N} \quad . \quad . \quad . \quad (1)$$

where h is the film thickness, b is the length of the underface of the slider in the direction of motion, η is the viscosity of the lubricant, U is the velocity of sliding, and N the external load. The leading face of the slider is at right angles to the underface and the leading edge of the underface is ideally sharp. The coefficient of friction is

$$\mu = \frac{\pi}{3} = 1{\cdot}047. \quad . \quad . \quad (2)$$

That is to say, this is a purely hydrodynamical friction, just about equal to the applied load. Note that it is independent of the usual parameters like the viscosity of the lubricant, the velocity of sliding, and the size of slider. Both results are believed to be within about ±5 per cent. of their true values when the ratio $\frac{h}{b} < 0{\cdot}01$, provided that the depth of the lubricant layer gathered by the leading face of the slider and piled up in front of it is not less than $100h$.

The last result can be identified with what is often thought to be boundary friction. It also follows that there is no substance in the widespread belief that fluid friction should always be very small, such as, say, $\mu < 0{\cdot}05$, and that it should always be proportional to the viscosity of the lubricant. For the elements of machinery such as piston rings, commutator brushes, etc., the provisional figure for the film thickness by (1) is the order of 10^{-4} cm. per cm. of the underface in the direction of motion, and possibly several times more if the elastic deformation of the underface is taken into account. In the case of commutator brushes the supporting fluid film, h, consists of the atmospheric air, gathered hydrodynamically..

Throughout the vast literature on the subject of boundary lubrication there seems to be no overwhelming evidence, which could not be questioned, that molecular phenomena play an important role in the surface wear and friction of the common kind in engineering. For instance, Hardy's classical experiment with a watch glass pulled along a slab of plate glass does not necessarily prove his contention that molecular adhesion plays an important role in producing the scratches at the point of " touch." Since Hardy's experiments were done in air (not vacuum) there could be no question of not lubricating the surfaces. The scratches might, just as well, have been due to ploughing by some minute splinters of glass heat-chipped off the surfaces through the frictional heat evolved just after starting the motion. Alternatively, there might have been some abrasive particles of sub-microscopic dimensions to start with. Such particles might be thousands of molecules across, yet they would still be far beyond detection by any practical means.

There is in the literature, a wealth of questionable evidence in support of the theory of boundary lubrication of the kind where the chemical nature of the lubricant and of the surfaces themselves appear to make the surfaces more or less slippery. There is, of course, nothing wrong with the suggestion that the layers of oriented molecules may be slippery. The point is that in real conditions at a metallic surface the regions where this sort of mechanism might operate must be extremely rare, say one in a million. Perhaps the corrosive action simply makes the surfaces smoother geometrically, by destroying most of the abrasive debris torn from the peaks of surface asperities, thus affecting the hydrodynamic lubrication. It is quite a different matter that it may be difficult to compute the effect.

Returning now to the equations (1) and (2), one point deserves a particular attention. If the elastic deformation of the underface of the slider is taken into account, and with ideally smooth surfaces, the film thickness might be many times more and the coefficient of friction correspondingly less. This explains why the coefficient of " boundary " friction is often found to be quite small, say 0·05 to 0·15. Note in this connection that in the customary experimental set-ups, the " stick-slip " pattern of frictional behaviour is artificially averaged out. However, the " stick " and " slip " stages appear to be two different mechanisms of a hydrodynamic nature, not unlike the parallel and convergent sliders, which obey entirely different laws. Ordinarily, the two mechanisms would alternate as the angle of convergence of the slider is varied by the mechanical vibration of its body and support.

There remains an interesting point to be answered, why the discrepancy between the Reynolds solution and reality was never found by experiment. Various electrical resistance methods used in the past to measure the thickness of the film were at fault. They lead to the belief that the thickness is something like a millionth of its true magnitude, much in accordance with what Reynolds lubrication theory has predicted. It is only recently that a method has been discovered of measuring what is believed to be the true film thickness.*

Yours faithfully,
W. LEWICKI.

Imperial College of Science
and Technology,
London, S.W.7.
November 8, 1955.

* The work referred to has been carried out by the present writer in the Department of Chemical Engineering Imperial College of Science and Technology, in association with the Department of Physics, Birkbeck College, London.

* W. Lewicki, " Some Physical Aspects of Lubrication in Rolling Bearings and Gears," *The Engineer*, pages 176 and 212 vol. 200 (1955).

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WAKEFIELD SCHOLARSHIPS

The College of Aeronautical and Automobile Engineering, Chelsea, London, S.W.3, announces that two annual scholarships in memory of the late Viscount Wakefield, G.C.V.O., former president of the College, have been founded and will be maintained by the generosity of C. C. Wakefield and Company, Limited.

These scholarships will be worth £300 and £150 per annum respectively. The former will be awarded to a student for training in automobile engineering to the standard of an associate membership of the Institution of Mechanical Engineers. The latter will be awarded to a student for training to the standard of the examination in agricultural engineering set by the department of technology of the City and Guilds of London Institute.

PERSONAL

MR. HORACE WILLSON, M.I.N.A., M.I.E.S., has been elected President, for the coming year, of the Shipbuilding Employers' Federation, 1 Chester-street, Grosvenor-place, London, S.W.1, in succession to MR. C. A. WINN, M.I.N.A. MR. JOHN HUNTER, M.I.N.A., M.I.Mar.E., becomes senior vice-president, while MR. G. C. PARKER, M.I.N.A., M.I.E.S., and MR. R. W. JOHNSON have also been appointed vice-presidents. MR. HOWARD JOHNSON, M.I.N.A., M.E.I.C., has been elected chairman of the Conference and Works Board, and MR. JAMES TOCHER, vice-chairman.

MAJOR-GENERAL R. E. URQUHART, C.B., D.S.O., who commanded the 1st Airborne Division at the Battle of Arnhem in September, 1944, has joined the staff of the Davy and United Engineering Co., Ltd., Park Iron Works, Sheffield, 4, in an administrative capacity.

MR. J. H. BEAN, C.B.E., has recently retired from the boards of Garringtons Ltd., Bromsgrove, Worcestershire, and Guest, Keen and Nettlefolds Ltd., Smethwick. He is continuing, however, to serve as chairman of Beans Industries Ltd., Midland Industries Ltd., and B.R.D. Ltd.

SIR GODFREY INCE, G.C.B., K.B.E., permanent secretary to the Ministry of Labour and National Service, is retiring from the Civil Service in January, 1956. He will be succeeded by SIR HAROLD EMMERSON, K.C.B., K.C.V.O., who is now permanent secretary to the Ministry of Works. MR. E. F. MUIR, C.B., will succeed Sir Harold Emmerson as permanent secretary to the Ministry of Works.

MR. RALPH SIMPSON, M.B.E., administrative officer for No. 3 area of the Northern (Northumberland and Cumberland) Division of the National Coal Board, at Ashington, Northumberland, since 1950, has been appointed administrative manager of the Industrial Group, United Kingdom Atomic Energy Authority, at Risley, near Warrington, Lancashire. He is to take up his new post next year.

The President and Council of the Royal Society, Burlington House, London, W.1, have awarded the Davy Medal to PROFESSOR H. W. MELVILLE, F.R.S., Mason Professor of Chemistry, University of Birmingham, for his work in physical chemistry and in polymer reactions; the Sylvester Medal to PROFESSOR E. C. TITCHMARSH, F.R.S., Savilian Professor of Geometry, University of Oxford, for his researches on the analytical theory of numbers, and other branches of pure mathematics; and the Hughes Medal to PROFESSOR H. S. W. MASSEY, F.R.S., Quain Professor of Physics, University College London, for his contributions to atomic and molecular physics, particularly in regard to collisions involving the production and recombination of ions,

MR. H. H. UTLEY, A.M.I.Mech.E., A.I.M., manager of the Cleveland Works of Dorman Long (Steel) Ltd., Middlesbrough, has been installed as President of the Cleveland Institution of Engineers, Middlesbrough, in succession to MR. H. M. MORGAN, works engineer, Cargo Fleet Iron Co. Ltd., Cargo Fleet Ironworks, Middlesbrough.

The Ministry of Supply announce that MR. J. D. PARSONS, M.Sc., M.I.Chem.E., A.R.C.Sc., has been appointed director of Ordnance Factories (Explosives).

The Illuminating Engineering Society, 32 Victoria-street, London, S.W.1., has conferred honorary membership upon MR. H. C. WESTON in acknowledgement of his valuable services to the Society.

MR. N. A. DEIGHTON, formerly chief engineer, J. and H. McLaren Ltd., Leeds, is now chief engineer (sales); MR. J. R. FISH, formerly chief designer is now chief engineer (design).

MR. L. S. GREENLAND, chief designer, H.M. Hobson Ltd., has been elected a director of the company.

MR. F. R. NEWTON, chief of the data department, British Thomson-Houston Co., Ltd., Rugby, has retired after nearly 36 years of service with the company.

MR. R. H. SMITH, foundry manager to C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, has retired after 52 years of service with the firm.

The Chadwick Medal and Prize for excellence in municipal engineering and hygiene has been awarded to MR. C. A. W. DEANE, B.Sc.(Eng.), who comes from British Guiana and was formerly a student in the Chadwick Department of Civil and Municipal Engineering, University College London. He was recommended for a three-year course at University College by the Colonial Office. Mr. Deane has since returned to British Guiana.

The Board of Trade have appointed MR. H. T. RENOUF, United Kingdom Trade Correspondent in Newfoundland, to replace MISS W. CALDWELL, M.B.E., who has retired. Mr. Renouf's address is: Newfoundland Board of Trade, Water-street, St. John's, Newfoundland.

MR. HOWARD GAYDON, commercial director of the Small Heath Group of the B.S.A. Co. Ltd., Birmingham, 11, a director of B.S.A. Motor Cycles Ltd., has been appointed to the boards of B.S.A. Cycles Ltd., and B.S.A. Guns Ltd., with effect from October 21.

MR. A. C. SNOWDEN, M.B.E., a director of J. H. Minet & Co. (Home) Ltd., has joined the board of Hayward Tyler & Co. Ltd., of Luton and Glasgow.

MR. E. B. FOSKETT has been appointed manager of the Glasgow office of Honeywell-Brown Ltd., in succession to MR. D. J. VENNING, who has been given a senior appointment in the company's head office at Perivale, Greenford, Middlesex.

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COMMERCIAL

At an extraordinary general meeting of the DE HAVILLAND AIRCRAFT CO. LTD., to be held at Hatfield, Hertfordshire, on November 30, the main proposal to be submitted will be that the company be renamed DE HAVILLAND HOLDINGS LTD. The three main operating subsidiary companies at home will then be: The DE HAVILLAND AIRCRAFT CO. LTD., the DE HAVILLAND ENGINE CO. LTD., and DE HAVILLAND PROPELLERS LTD. MR. A. F. BURKE will take over the office of managing director of the Aircraft Co. on January 1, 1956, and MR. H. BUCKINGHAM will then assume the duties of principal executive officer of the Engine Co. as general manager. Until that date MR. W. E. NIXON will be managing director of the Aircraft Co. and MR. A. F. BURKE, managing director of the Engine Co.

HADFIELDS LTD., East Hecla Works, Sheffield, 9, have appointed MR. J. HANSCOMB, B.A., and MR. G. E. GILL to be their sales representatives in Scotland in succession to PAUL & MACLEOD LTD. The office accommodation previously occupied by Paul & MacLeod, at 82 Gordon-street, Glasgow, C.1, has been acquired for the firm's Glasgow office.

THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., have made arrangements with the LANCASHIRE STEEL CORPORATION LTD., their largest supplier of steel wire, for the establishment of a company which will be owned in equal shares by the two parent companies. The new company, to be known as B.R.C. STEEL CO. LTD., will carry on the business of wire drawing in a factory to be erected on the British Reinforced Concrete Co's. property at Stafford. The output will be solely for that company's own consumption.

TEDDINGTON INDUSTRIAL EQUIPMENT LTD., Sunbury-on-Thames, Middlesex, have opened a new office and warehouse, which will provide technical advisory services and trade counter facilities in Scotland, at 255 St. Vincent-street, Glasgow, C.2.

W. J. FRASER & CO. LTD., chemical engineers, have built a new plant at Harold Hill, Romford, Essex, for pilot-scale investigations. The new plant which will come into operation before the end of the year, will replace the company's previous laboratories at Dagenham.

THE PLESSEY CO., LTD., Ilford, Essex, announce that a new company, the PLESSEY DEVELOPMENT CO. LTD., has been formed. The company, it is stated, constitutes an administrative unit designed to provide and blend American abilities in design and production with the Plessey Group's production capacity. The directors of the new company are MR. A. G. CLARK, who is chairman and managing director, and MR. E. J. EARNSHAW and MR. A. E. UNDERWOOD.

A large extension for plant manufacture is now being built by BRITISH OXYGEN ENGINEERING LTD., at Upper Edmonton, London, N.18. The completion of the new plant buildings will bring to a conclusion a programme begun in 1954 to centralise the engineering and plant-manufacturing activities of the BRITISH OXYGEN CO. LTD. at Edmonton.

On January 1, 1956, the BRITISH RUBBER DEVELOPMENT BOARD will be renamed the NATURAL RUBBER DEVELOPMENT BOARD, Market Buildings, Mark-lane, London, E.C.3. The alteration in the title signifies no change in the Board's activities but will serve to emphasise that these are confined to natural rubber.

THE INDUSTRIAL FAN & HEATER CO. LTD., " Airflo " Works, Birmingham, 11, have opened a South Wales office at 256 Oxford-street, Swansea. (Telephone: Swansea 50149). MR. W. BRITTLE is in charge.

HONEYWELL-BROWN LTD. have moved their Sheffield office from Oak Dale-road to larger premises at 119 Petre-street, Sheffield, 4. The office is under the management of MR. W. R. OWEN.

CONTRACTS

Atomic Power Station. The United Kingdom Atomic Energy Authority have placed a contract with the MITCHELL CONSTRUCTION CO., of Peterborough, for the civil engineering work on the new atomic power station at Chapelcross, Annan, Dumfriesshire. Some 300,000 tons of sandstone will have to be excavated to form the foundations for the reactors and the turbine house and about 400,000 tons of concrete will be used in the construction operations. Work will commence next month and is expected to take about 3½ years. The consulting engineers are MERZ AND MCLELLAN, of London. Messrs. Mitchell are engaged on another Atomic Energy Authority contract at Capelhurst, near Chester, where they are building six cooling towers for the atomic power station there.

Jet Bomber Aircraft. An order for eight Canberra jet bombers has been placed by the Peruvian Government with the ENGLISH ELECTRIC CO. LTD., Preston, Lancashire. The order is for the Mark 8 version of the Canberra, equipped for two roles, namely, as a night intruder carrying four cannon and bombs, and as a high-level bomber. Delivery of the aircraft will commence in the spring.

Power-Station Water Screens. F. W. BRACKETT & CO., LTD., Hythe Bridge Ironworks, Colchester, have received a contract from the Metropolitan-Vickers Electrical Co. Ltd., Manchester, for circulating water screens for five power stations in Spain. These will be installed at Almeria, Malaga, Ceuta, Cadiz and Mallorca.

Cables for Antarctic. ENFIELD CABLES LTD., Victoria House, Southampton-row, London, W.C.1, announce that they have been chosen to supply the electric cables to be used by the Commonwealth Trans-Antarctic expedition, the advanced party of which sailed on November 14. The cables will be used for receiving and transmitting radio reports; as part of the beacon installation for guiding supplying aircraft; on various meteorological instruments; in the mobile workshop for on-the-spot repairs; and as an essential link in the mobile lighting systems in the various camps. All these duties will be conducted in external temperatures varying between + 50 deg. and − 90 deg. F., and to meet such exacting conditions a plastic insulation which will remain flexible at sub-zero temperatures has been used.

Induced-Draught Cooling Tower. The Government have placed an order with HEAD WRIGHTSON PROCESSES LTD., Teesdale House, 24-26 Baltic-street, London, E.C.1, for what is stated to be the largest induced-draught cooling-tower installation of its kind in the United Kingdom. The firm have developed, in co-operation with JOHN LAING & SONS, LTD., an induced-draught cooling tower structure in which all the main units are constructed of factory pre-cast concrete and special consideration has been given to an even distribution of the structural load.

Diesel Engines. A Canadian agent of W. H. DORMAN & CO. LTD., Tixall-road, Stafford—MECHRON ENGINEERING PRODUCTS LTD., Ottawa, Ontario—have been awarded a contract, valued at 2 million dols., by the Department of Defense Production, for a considerable number of electric generating sets for the Mid-Canada DEW (distant early warning) stations. The prime movers for these sets will be Dorman " L "-series Diesel engines to be manufactured at the Tixall-road factory of the firm in Stafford.

Broadcasting Station. A contract for a complete new high-power broadcasting station, to be sited at Abu Ghraib, near Baghdad, has been placed by the Iraq Posts and Telegraphs Department with MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex. Four 100 kW air-cooled transmitters are included in the order, together with programme input equipment, automatic monitoring equipment and a four-channel super-high-frequency music link for use between the Baghdad studios and the transmitting station. A 165 m. half-wave mast radiator and an H.F. aerial system form another part of the order. Delivery of the technical equipment will be completed by October, 1956.

Electric Rolling-Mill Equipment. An order, valued at approximately £400,000, has been received by the BRITISH THOMSON-HOUSTON CO. LTD., Rugby, through their associated company, AUSTRALIAN ELECTRICAL INDUSTRIES PTY. LTD. The order covers electrical driving equipment for an 18 in. continuous steel strip and skelp rolling mill to be installed at the Newcastle Works, New South Wales, of the Broken Hill Proprietary Co. Ltd. The plant to be supplied by the B.T.H. company includes 14 direct-current motors totalling 9,800 h.p., two 3,500 kW banks of grid-controlled mercury-arc rectifiers.

Obituary

MAJOR C. E. WILLIAMS, C.B.E.

Colonial Railways

We regret to record the death of Major C. E. Williams, which occurred at the age of 82 at Parkstone, Dorset, on Tuesday, November 8. He had had a distinguished career as chief inspecting engineer of the Crown Agents for the Colonies, and was well known as an expert on the subject of colonial railways.

Charles Edward Williams was born in 1873 and was educated at Llandovery College. His first appointment was that of assistant works manager of the Vulcan Locomotive Works, but in 1898 he became an inspector of railways in New Zealand. Returning to this country in 1901 he joined the Darlington works of Robert Stephenson and Company, Limited, as assistant manager, and three years later began his long association with the Crown Agents when he was appointed deputy chief inspecting engineer. He was promoted to be chief inspecting engineer in 1922, a post he held until 1934. For the next three years he was railway engineer of the United Steel Companies and then, until 1946, General Manager of the C.W. Railway Engineering Works.

His period of service with the Crown Agents was broken by the 1914-18 war, during which he attained the rank of major in the Royal Engineers. He became an Officer of the Order of the British Empire in 1918 and was promoted to be a Commander of the same Order in 1933. He was elected an Associate Member of the Institution of Mechanical Engineers in 1900 and was transferred to the class of Member in 1907. He was also a past-President of the Institution of Locomotive Engineers and was the author of a book on colonial railways.

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MR. H. C. MAKEPEACE

Civil Engineering for Television

We also regret to record the death of Mr. H. C. Makepeace, which recently occurred at Bristol at the age of 68. He was for many years responsible for the mechanical engineering work connected with the television studios and transmitting stations of the British Broadcasting Corporation and later, with Sir William Halcrow and Partners, was engaged on the construction of the central terminal at London Airport.

Harold Cragg Makepeace was educated at Hampton Grammar School and received his technical training at the Crystal Palace School of Engineering. Subsequently he was engaged with S. Pearson and Son, Limited, on the construction of the Admiralty Harbour at Dover, the extension of the Royal Albert Dock, London, and the Stanlow Oil Dock, Cheshire. During the 1914-18 war he served in the Royal Engineers and took an active part in the design of the Channel Ferry terminals at Dunkirk, Calais and Dieppe. He was also assistant port engineer at Rouen and Dunkirk.

From 1925 until 1932 Makepeace acted as assistant chief engineer to the Gramophone Company, Limited, with whom he carried out large extensions to the Hayes factory. In the latter year he joined the British Broadcasting Corporation as chief assistant to the civil engineer, Mr. M. T. Tudsbery and, as we have already noted, was engaged on the construction of television studios, at Alexandra Park and Lime Grove, as well as the transmitters at Wrotham, Sutton Coldfield, Holme Moss, Kirk o'Shotts and Wenvoe. On his retirement from the Corporation in 1952 he became design co-ordinating engineer with Sir William Halcrow and Partners.

Mr. Makepeace was elected an Associate Member of the Institution of Mechanical Engineers in 1920 and was transferred to the class of Member in 1944.

We regret also to record the deaths of:

Mr. Seymour Booth on October 30 at the age of 81. He was a director of the British Vacuum Cleaner and Engineering Co., Ltd., Goblin Works, Leatherhead, Surrey, for many years, having joined the firm in 1904.

Mr. John Barrington Pearson, of Wetheral, Cumberland, on November 1, at the age of 73. Mr. Pearson retired, in 1953, from the board of Cowans, Sheldon & Co., Ltd., Carlisle, after nearly 40 years of service with the firm. He began his career with the old North Eastern Railway Co. and joined, Cowans, Sheldon in 1914 as general manager. In 1920 he was elected managing director and in 1929 chairman.

Mr. George Arthur Skentelbery, O.B.E., at Gosforth, on November 4, at the age of 79. Prior to his retirement, four years ago, Mr. Skentelbery had been connected with the North-East Coast shipbuilding industry all his working life. He had held executive positions with Palmers Shipbuilding and Iron Co. Ltd., Blyth Dry Docks and Shipbuilding Co. Ltd., and Brigham and Cowan Ltd., South Shields.

Mr. Albert Eduard Whyman at his home in Fulham, London, on November 8, at the age of 53. He was chairman and managing director of E. W. Bliss (England) Ltd., power-press manufacturers, City-road, Derby, and had been associated with the firm since 1945. Mr. Whyman was also President of the E. W. Bliss associated French company in Paris.

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ADVANCED COURSES FOR ENGINEERS

Institutions' Joint Discussion

A number of advanced courses on a wide variety of subjects are already held at universities and technical colleges throughout the country, and committees of various kinds have recommended, from time to time, the development of similar courses for the benefit of engineers who have been engaged in industry for longer or shorter periods since completing their training at a university or technical college.

Arrangements have now been made by the Institutions of Civil, of Mechanical, and of Electrical Engineers to hold a joint meeting to discuss this question. It will be held at the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1, on Monday, January 16, 1956, commencing at 5.30 p.m., when papers on " Advanced Courses for Engineers in Industry " will be presented by representatives of each of these institutions. The authors will be Mr. H. D. Morgan, M.Sc.(Eng.), M.I.C.E., for the Institution of Civil Engineers, Professor G. F. Mucklow, D.Sc., M.I.Mech.E., for the Institution of Mechanical Engineers, and Dr. Willis Jackson, M.I.E.E., F.R.S., for the Institution of Electrical Engineers.

The symposium will be open to members of all three institutions and they are also invited to take part in the discussions.

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MACHINERY FOR OIL WELLS

British Productions

As the world demand for oil grows so does the demand for oil drilling equipment. In the past this has been made in an overwhelming proportion by the Americans because of their own rapidly expanded and now enormous oil industry ; having gained experience both in drilling and in making drilling machines, they were then well placed to sell both knowledge and machines to the rest of the world. In spite of her wide interests in oil, Great Britain has never produced much drilling machinery, partly because of a preference for equipment made by the experienced Americans, and partly by a lack of any extensive local drilling requirements.

In the last few years, however, there have been efforts made by a small number of firms to compete in this field, although the equipment produced is often based on American designs. One of the firms so engaged has been Woodfield Hoist and Associated Industries, Limited, of Rochester, who made the drilling rig for the D'Arcy Exploration Company's experimental natural gas well in Sussex. Recently they have completed a rig mounted on a special trailer made by Cranes (Dereham), Limited, Dereham, Norfolk. The rig is completely self-contained, with three Rolls-Royce Diesel engines mounted on the trailer, and can drill to a depth of 7,000 ft. using 4½ in. drill pipe. The length of the trailer is 47 ft. A trailer of such a length is too long to be manoeuvred in any confined space, and Woodfield Hoist are now making a drilling rig for Venezuela which will be mounted on two trailers, conforming to the latest American design. It is hoped that these rigs will be ready by next January.

The field for drilling equipment is large and expanding. Of particular interest to the makers of this type of equipment are the possibilities for natural gas in Great Britain and oil in Italy. If either natural gas or oil are found in large quantities in Great Britain, British manufacturers will have an excellent opportunity to produce the equipment the oil companies need. The presence of oil in commercial quantities is established in Sicily and virtually assured in continental Italy. When the Italian Government has passed a satisfactory mining law the demand for drilling equipment will rise rapidly, and British manufacturers will have a good opportunity to show the worth of their products.

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STEAM AND STEAMSHIPS

Numerous Designs Preceded First Success

Ships propelled by steam had been designed many years before the first steamships sailed; some of the designs were discussedby Mr. H. Philip Spratt, B.Sc., A.S.M.E., in a paper entitled " The Prenatal History of the Steamboat," given to the Newcomen Society on November 9, 1955.

The idea behind most of the early designs was to make the ship independent of the vagaries of the winds. The propelling machinery was to consist of paddle wheels or oars driven by some form of engine; in the earlier designs the engine was in fact some form of animal power, although there were inventors who realised the possibilities of steam. The Frenchman Denis Papin (1647-1714) was the first to publish a definite proposal for a steamship. A steam cylinder was fitted with a piston which descended under atmospheric pressure when the steam below it was condensed; two or three pistons were used, each fitted with a separate rack which could in turn be meshed into or withdrawn from a pinion on paddle-wheel shafts, thus turning the paddle-wheels. Although he was never able to make practical tests, Papin can be considered as the true inventor of the steamship.

A steam tug-boat was proposed in 1736 by Jonathan Hulls, which had a paddle-wheel at the stern driven by a Newcomen atmospheric engine. To obtain continuous rotation from the motion of the engine a system of ratchet wheels was used. A somewhat similar proposal was put forward by Joseph Gautier in 1755, and he made the interesting calculation that the food required for 260 oarsmen would exceed in volume the coal required for a Newcomen atmospheric engine to do the same work.

The improvements made by James Watt to the steam engine overcame many of the problems which had hindered its mechanical development, and contributed much to the success of practical experiments with steamships. Although Watt was not himself interested in ships, he constructed the machinery fitted by Robert Fulton in the Clermont (1807), the first steamship to attain commercial success. The firm Boulton, Watt and Company also supplied steam engines for the P.S. Swiftsure, built at Montreal in 1813, and for the P.S. Prinzessin Charlotte (1816), the first steamship to run in Germany.

PREVENTIVE MAINTENANCE AND RUNNING REPAIRS

SUGGESTED LAYOUTS FOR COLLIERY WORKSHOPS AND STORES

In accordance with National Coal Board policy, much of the heavy maintenance work now carried on in colliery workshops will be handled by central workshops serving groups of collieries. These will deal with most of the cyclic maintenance, leaving the colliery workshops to carry out preventive maintenance and "first-aid" repairs. The colliery workshops will also be combined with stores for handling items for the normal working of the colliery, such as roof supports and lubricating oils. Suitable layouts for colliery workshops and stores are described in the National Coal Board's Information Bulletin No. 55/148. The buildings described could well be adapted to other types of work besides that of colliery maintenance.

The essential services required are: an engineering workshop; means of dealing with the supply of components and stores to both the workshop and the colliery, and facilities for dealing with bulky stores and materials to the colliery only. In planning the layout of the buildings and storage spaces attention has to be paid to a number of important points, including the necessity for reducing the handling of materials and work in progress, and the time taken by men to travel to the stores and obtain the equipment needed. The point of receipt of goods by road or rail must be as close to the storage point as possible, and the complete group of stores and workshop must obviously be conveniently sited in relation to the colliery shaft.

BASIC TYPES FOR DIFFERENT SITES

The Information Bulletin gives suggestions for three basic types of stores and workshop: parallel, angle and linear, which are adaptable to narrow, angle, or long sites respectively. All three types meet the full requirements for operating efficiency, and sites varying from virgin ground to spaces between existing buildings can thus be used. The size of the workshop and stores has to be related to the services required by the colliery and it is impossible to lay down precise rules. Roughly speaking, a colliery producing up to 1,000 tons of coal a day would require a workshop and stores with a total floor area of 4,225 sq.ft. (including offices), and a colliery producing from 4,001 to 5,000 tons a day would require 14,100 sq. ft. Daily productions between these two figures would indicate floor areas in proportion.

In all cases particular attention has been paid to the following features: (1) The shops have wide, clear, uninterrupted spans, which enables the work to flow more easily and is conducive to cleanliness; (2) An overhead crane is available to all sections of the shops, including the area for storage of stand-by machinery; (3) There are no walls dividing the shops into isolated units, which permits better supervision, and often reduces the handling time of work passing through; (4) All common services are conveniently sited in relation to the sections using them; (5) The stores are so sited as to give service to both the workshops and the colliery, with the receipts and issues points in the proper sequence, under the direct control of the storekeeper; (6) Provision is made for controlled expansion of each workshop or stores section, either separately or collectively.

Many types of pre-fabricated steel structure suitable for workshops and stores are now available. They show a saving in cost and erection time over conventional buildings and can, if necessary, be dismantled and re-erected elsewhere. A typical workshop building would be of 60 ft. span, with a minimum eaves-height of 15 ft., or 18 ft. if an overhead crane is installed. The stores building to serve this workshop would be of 45 ft. span, with a height to the eaves of 14 ft.

WORKSHOP EQUIPMENT

The range and type of machine tool would be governed by the type of work done at the colliery and the strength of the supporting workshop. A typical layout for a colliery producing between 1,001 and 2,000 tons of coal a day would include blacksmiths, machine, fitting, electrical and platework shops under a single roof, and a separate carpenters' shop.

The suggested equipment includes a 6 in. gap-bed centre lathe, 3 ft. 6 in. radial drilling machine, 6 in. pipe screwing machine, single-spindle drilling machine, tool grinder, and a power saw. Gas and electric welding equipment are provided, and there is an appropriate number of work benches. Blacksmiths' equipment includes a 3 ft. hearth of the down-draught type, anvil and swage block. In the plate-working section there is a hydraulic horizontal arch-straightener. The adjacent carpenters' shop is equipped with a universal wood working machine, and workbenches. Equipment in workshops at collieries with larger outputs is of a similar nature, but the number of individual units is increased, and certain heavier equipment is added.

The general equipment of the stores calls for no special comment, but there is one item which the stores handle which does come in for particular attention. This is lubricating oil, which is not always given the care it warrants in some colliery stores. It is particularly important that the oil shall not be contaminated, that the various grades shall be identified clearly, and that the amount of handling shall be reduced as far as possible. The method suggested involves the storage of the various grades of oil in buried tanks, into which it is delivered in bulk from road or rail tank wagons.

From these tanks it is pumped as required to metering pumps, each one being coloured in accordance with an oil identification code, into a tank mounted on a tub or railcar. These tanks are divided into compartments according to the storage required underground. They are sent down the shaft and stored at convenient and safe points underground. Oil is dispensed from the tanks through metered pumps to containers with self-sealing filling points and self-closing draw-off cocks. These are mounted on suitable fittings adjacent to the coal-face, for replenishing hand-operated pressure oil cans. The colour code is used throughout the system, the various oiling points on the machinery being painted appropriately. Thus a red point on a machine is oiled from a red oil can, which is filled from a red container and so on back to the original storage point at the surface.

LAUNCHES AND TRIAL TRIPS

S.S. "GROOT CONSTANTIA."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, to the order of Irvin and Johnson, Ltd., Cape Town, for their associated firm, the National Trawling and Fishing Co., Ltd., Cape Town, South Africa. Fourth vessel of this series built for these owners. Main dimensions: 141 ft. between perpendiculars by 27 ft. by 14 ft. to main deck; gross tonnage, about 490. Triple-expansion steam engine, constructed by Charles D. Holmes & Co., Ltd., Hull. Steam supplied by one return-tube Scotch boiler. Launch, October 18.

S.S. "NAREK."—Single-screw oil tanker, with accommodation for a small number of passengers, built by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for the Baltic Trading Co., Ltd., London, E.C.2. Main dimensions: 552 ft. between perpendiculars by 75 ft. by 40 ft.; deadweight capacity, about 20,000 tons. Parsons double-reduction geared steam turbines, developing 8,700 s.h.p. at 100 r.p.m., constructed by David Rowan & Co., Ltd., Glasgow. Steam supplied by two Foster Wheeler oil-fired water-tube boilers. Mean trial speed exceeded 16 knots, fully loaded. Trial trip, October 18.

M.S. "ARJEPLOG."—Single-screw bulk-carrying cargo vessel, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Trafikaktiebolaget Grängesberg-Oxelösund, Stockholm, Sweden. Main dimensions: 490 ft. overall by 64 ft. by 42 ft. 6 in.; deadweight capacity, 13,000 tons on a draught of 27 ft. 6 in. Götaverken seven-cylinder single-acting two-stroke Diesel engine, developing 5,000 b.h.p. at 112 r.p.m. Service speed 14¼ knots, fully loaded. Launch, October 18.

S.S. "NEW YORK CITY."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by John Readhead & Sons, Ltd., South Shields, for the United Kingdom, Canada and United States service of the Bristol City Line of Steamships Ltd., Bristol. Main dimensions: 425 ft. between perpendiculars by 57 ft. 9½ in. by 38 ft.; deadweight capacity, about 8,500 tons on a draught of 25 ft. Triple-expansion steam reciprocating engine working in conjunction with a Bauer-Wach low-pressure exhaust turbine and developing a total of 4,600 i.h.p. Steam supplied by three oil-fired boilers. Service speed, 13½ knots. Launch, October 18.

M.S. "EDEN."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Belfast, for the London to Central America route of the Royal Mail Lines, Ltd., London, E.C.3. Fourth of a series of eight cargo-passenger liners on order for these owners. Main dimensions: 415 ft. between perpendiculars by 58 ft. 6 in. by 38 ft. 4 in. to shelter deck; gross tonnage, about 7,450. Harland-B. and W. six-cylinder single-acting two-stroke opposed-piston Diesel engine, arranged to operate on heavy fuel or Diesel oil. Launch, October 19.

H.M.S. "PICTON."—Twin-screw coastal minesweeper, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for the Admiralty, London, S.W.1. Main dimensions: 152 ft. by 28 ft. 9 in. by 14 ft. 9 in.; armament three small guns. Standardised Diesel propelling machinery supplied by Mirrlees, Bickerton and Day, Ltd., Stockport, Cheshire. Launch, October 20.

M.S. "KYOTO."—Single-screw cargo vessel, with accommodation for a small number of passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, to the order of the Swedish-Eastasiatic Co., Gothenburg. Sister ship of M.S. Minikoi. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 38 ft. 6 in. to shelter deck; deadweight capacity, 8,400 tons on a draught of about 25 ft. 8 in.; cargo-carrying capacity, 540,000 cub. ft. bales (including 38,000 cub. ft. refrigerated space). Eriksbergs-B. and W. seven-cylinder single-acting two-stroke Diesel engine, developing 8,300 b.h.p. and arranged for operating on heavy oil. Service speed 17 knots, fully loaded. Launch, October 20.

M.S. "TRIASTER."—Single-screw vessel for the carriage of phosphate cargoes and 48 passengers, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for the British Phosphate Commissioners, London, S.W.1. Main dimensions: 485 ft. between perpendiculars by 67 ft. 6 in. by 42 ft. to shelter deck; deadweight capacity, about 12,000 tons. Harland and Wolff six-cylinder single-acting two-stroke Diesel engine, developing 6,500 b.h.p. at 110 r.p.m. in service. Engine arranged for burning heavy oil, with Diesel oil as a standby. Delivered, October 25.

M.S. "LAGANBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. This ship is the last of a series of six vessels being constructed for these owners; and a second series, of six larger ships, has been ordered. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder single-acting two-stroke Diesel engine. Delivered, October 26.

M.S. "MANES."—Single-screw cargo-vessel, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for Motornaves Limitada, Costa Rica. Main dimensions: 435 ft. between perpendiculars by 61 ft. 9½ in. by 38 ft. 3 in. to weather deck; deadweight capacity, 12,480 tons on a draught of 29 ft. Sulzer seven-cylinder single-acting two-stroke Diesel engine, developing 4,825 b.h.p. at 125 r.p.m. in service on heavy-fuel oil. Propelling machinery installed by the shipbuilders. Trial trip, October 26.

Book Reviews

ENGINEERS IN THE ROYAL NAVY

"Up Funnel, Down Screw!" The Story of the Naval Engineer. By COMMANDER GEOFFREY PENN, R.N. *Hollis and Carter, Limited, 25 Ashley-place, London, S.W.*1. (16*s.*)

The late Engineer Captain Edgar C. Smith, who contributed to ENGINEERING, over more than 50 years, so many notable articles on the development of British naval engineering and of the Engineering Branch of the Royal Navy, was himself responsible for gathering most of the material on which those articles and his various papers to the Newcomen Society were based; but although he wrote an excellent *Short History of Naval and Marine Engineering*, it does not appear that he ever attempted the task of compiling its obvious complement, a history of the naval and marine engineer. So far as the naval engineer is concerned, however, that task has now been admirably accomplished by Commander Geoffrey Penn; and the tribute that he pays to Engineer Captain Smith—"my largest single source of information"—for his "constant help and encouragement at every stage," well deserved though we know it to be, should not be allowed to obscure the credit that is due to Commander Penn himself for his initiative in doing for the Engineering Branch what Commander C. N. Robinson, in *The British Tar in Fact and Fiction* and other works, did for the navigating officers and for the lower deck, more than 40 years ago.

As the first sentence of the preface proclaims, this is not a technical book, meaning thereby that it is not concerned with the development of naval machinery as such, but with the personnel who have operated and, to a great extent, maintained it during the 134 years that have elapsed since steam was first employed for the purposes of the Royal Navy; but inevitably there is some flavour of evolving technicalities to support and explain the changing status of the naval engineer. To those who—many of them in the columns of this journal—campaigned so long and earnestly for the enhancement of that status, it must have seemed that the change was very gradual; and yet, by comparison with the centuries that went to the evolution of the square-rigged ship of the line and the seamen who handled great fleets of them, the rise of the engineer has been almost rapid. Less than the sum of two normal lives will span the interval between the order of Captain Hugh Pigott that the Chief Engineer of the Alban should be flogged, and the statement that the Navy's engineer officers "are all first and foremost naval officers," in the foreword which Vice-Admiral Sir Frank Mason, K.C.B., Engineer-in-Chief of the Fleet, contributes to this book; yet none to-day would disagree with that statement, or, for that matter, think it remarkable that an engineer should become a Vice-Admiral and a Knight Commander of the Most Honourable Order of the Bath.

The story of that transition is concisely told by Commander Penn, with an entertaining leaven of anecdote and enough incidental quotation to make this a useful source-book for those who may wish to pursue the study farther. The last chapter deals with the Twentieth Century and its vastly accelerated changes. "There can be no doubt," the author observes, "that the story is by no means completed yet"; and, indeed, since the book was written there have been further changes, whereby the naval engineer has now shed the "(E)" which, for the past 30 years, has distinguished him from the officers of other branches. If and when a new edition of the book should be issued to take account of the disappearance of this last "caste mark," perhaps the opportunity may be taken also to correct a few minor errors in the spelling of certain names: of the Rev. Joseph Woolley (not Wooley), Director of the Royal School of Naval Architecture and Marine Engineering (wrongly indexed as on pages 29 and 83, instead of page 89) and a founder vice-President of the Institution of Naval Architects; of James Rumsey (not Rumsay), the West Virginian steamboat pioneer, who died in the Royal Society of Arts building in 1792 and to whom a memorial was unveiled in St. Margaret's, Westminster, in May of the present year; and of the vessel which, in 1825, made the first steam passage to India and which, according to the contemporary illustration in Vol. XIII of the *Transactions* of the Newcomen Society, was named Enterprize (not Enterprise).

Electromagnetic Principles of the Dynamo. By E. B. Moullin. *Oxford University Press, Amen House, Warwick Square, London, E.C.*4. (50*s.*)

"This book" writes the author "is concerned almost entirely with the physiology and little with the anatomy of the dynamo: relatively small space is devoted to details of construction and to description of those things which are often referred to as modern practice." He adds "This book is in no sense a manual of design; should the reader know it from cover to cover he would not be in a position to design a dynamo, but he would be adequately equipped to start learning the art and problems of design."

It may be added that Professor Moullin has exercised considerable self-control in carrying out his appointed task. There are no drawings of actual machines and the few photographs that are included only illustrate principles. On the other hand, there are a number of excellent diagrams and the mathematical treatment is restrained. The reviewer wishes that this book had been available in his student days, for then the many unhappy—and useless—hours during which he attempted to design a dynamo would have been more profitably spent in acquiring a deeper knowledge of principles.

As the title indicates, Professor Moullin is mainly concerned with direct-current machines. There is, however, a supplementary chapter which includes a large amount of the electromagnetic treatment required for alternating-current machines and should enable the reader to carry on with his study of that subject. After dealing with some basic principles, the ampere-hours on the poles are estimated and the magnetic effect of armature current is described. The behaviour of the machine as a whole is then considered in a chapter entitled "Characteristic Curves"; and this is followed by a discussion of efficiency and energy losses. Commutation is next dealt with exhaustively and certain special machines, such as boosters, balancers and amplifier machines, are considered in a concluding chapter. The text includes a number of illustrative examples, which are worked out in detail, while at the end of the book is a further collection of tests of knowledge assembled under the chapter headings.

As an instance of the author's treatment we may quote from his discussion of the fact that the magnetic field is unaffected by the notation of a direct-current armature. "The approach to this problem is" he says, "much simplified by supposing the armature is held at rest and is supplied with current from some external source. That such a condition is foreign to the normal use of the dynamo is irrelevant to the magnetic problem." Again, "the student should carefully adhere to ampere-hours per pair of poles, because this expression implies the complete magnetic circuit; each time it is used the student should sub-consciously picture himself carrying a magnetic pole and curling round the magnetic circuit."

It is a matter of interest that Professor Moullin has not adopted the practice, now becoming fashionable, of employing the M.K.S. system of units, but has used the C.G.S. and even on occasion the F.P.S. system, as is the habit of most designers. The information generally speaking is reasonably up-to-date, although an important improvement in commutator design is dismissed rather cursorily. This is the more regrettable since the treatment is more closely related to laboratory tests and experiments than is common in academic books of this kind.

The publishers are to be congratulated on their presentation of the text, except that the index, as in so many books, is inadequate. It also repeats a curious misprint in the text, which inserts a "p" in the name of J. J. Thomson. These are, however, minor blemishes on what is an outstanding contribution to electrical engineering literature. It is not too much to say that it is worthy of the attention of all students and equally of teachers of the subject.

Education and Training for Industrial Management. By AUBREY SILBERSTON. *Management Publications, Ltd., 8 Hill-street, London, W.*1. (12*s.* 6*d.*)

It was hardly to be expected that an inquiry conducted by a young research fellow from the ivory tower of a university would contribute much to our knowledge of the extent and value of management education in this country. To be fair to the author of this study, he makes no claims to have discovered anything new and a considerable part of his book is devoted to a description of present schemes of training for foremen and managers. These have grown greatly in recent years, particularly in the technical colleges, but it is in these colleges that doubts about the quality of much of the training chiefly arise.

Unfortunately there is no sure way of judging the effect of different kinds of training or, for that matter, of supervisory and management training at all. Mr. Silberston has been unable himself to conduct any deep inquiry into the subject, although some of his criticisms, for instance of the Harvard case-study system, are worth much fuller consideration. His views are, therefore, based on the limited amount of published research work done on this subject, chiefly in America, or on a few personal inquiries. The result is a sceptical support for organised training and some suggestions for its future development. These include post-graduate courses at the universities and larger technical colleges for those entering the middle ranks of management; more short, residential executive development courses for those with industrial experience about to take up responsible positions; and a second administrative staff college, like the existing college at Henley, possibly in the North of England, for those on the threshold of the higher ranks of management.

As the Kenward Research Fellowship, which Mr. Silberston held while undertaking this study, was founded by members of the motor and allied industries, he confined his inquiries into the practices of industry to firms within this category and the results form the most interesting part of his book. With the exception of one or two components firms, such as Dunlop and Lucas, not only have the firms in the motor industry hardly begun to consider management training (although foreman training has made some progress), but they seem to be opposed to the recruitment of university graduates, even engineering graduates. Reliance on filling the higher ranks is still based on promotion from the shop floor, irrespective of the background of education and training. On the other hand, corporate membership of the Institution of Mechanical Engineers, presumably acquired by "student apprentices" by part-time study at technical colleges, is stated to be highly regarded in the industry. There are signs that this situation is changing as the industry recognises that, with the universities more freely open to ability, more and more of those with the required qualities are receiving a university education and will not be available for direct recruitment from the schools. It would be interesting to try to find out if there is any connection between this conservatism on the part of the British motor-car industry in its recruitment of staff and the frequent accusations levelled against it of conservatism in research and design.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Construction of Housing-Estate Roads Using Granular Base and Sub-Base Materials. Road Note No. 20. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.*)

This publication is designed to help engineers in the preparation of specifications for housing-estate roads of flexible construction. It deals with the properties of granular bases and sub-base materials and seeks to encourage the use of relatively small-sized materials; these can be laid quickly and cheaply by machine in thin layers which can be compacted to such a degree by rolling and vibrating as to eliminate deformation of the pavement under traffic. Some cheap waste products are noted as being quite suitable for use in this form of road construction. The use of the California bearing ratio of determining the thickness required is recommended. Detailed instructions are given on the selection of test conditions and test procedure, and design curves are included for the classes of traffic likely to use such roads.

Readers Guide to Books on Automobile Engineering; and Readers Guide to Books on Electrical Engineering. *The Library Association, County Libraries Section, County Library, Widemarsh-street, Hereford. (Or from any County or Municipal Library.)* (1*s.* each.)

These booklets aim to serve as a brief guide to the more readily accessible literature on the subject covered. The one on "Electrical Engineering" includes British and American Publications, but does not cover radio and television, which are dealt with in a separate booklet. The "Automobile Engineering" booklet covers books which deal with some aspect of chassis or body engineering, but excludes the very highly specialised items. Books dealing with individual makes of car are also listed.

Proceedings of the First Congress of the Fédération Internationale de la Précontrainte, London, 1953. *Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1.* (50*s.*)

This volume is the published proceedings (i.e., the reports of the rapporteurs and the ensuing discussions) of the first congress on prestressing. Though the Federation does not restrict study to problems of prestressing concrete, these were the only issues considered at the congress. Three sessions were held to deal with the following topics: the influence of abnormal temperatures on prestressed concrete construction; the design of statically determinate beams and slabs in prestressed concrete, based on ultimate load; and statically indeterminate structures in the elastic and plastic states.

The following reports are obtainable from the Librarian, College of Aeronautics, Cranfield, Bletchley, Buckinghamshire:—

The Combustion Characteristics of a Cylindrical-Rod Burner System. By E. M. GOODGER. Report No. 90. (5*s.*) The report describes work on a combustion chamber in which fuel is fed under gravity down the surfaces of vertical cylinders located normally to the airstream. It was found that satisfactory combination of kerosine can only be established over a narrow range of fuel flow for each air flow, and that the maximum air speed before extinction was no higher than 70 ft. per second. The combustion intensity was localised, with a very high air/fuel ratio and poor temperature distribution near the flames. Increasing the number of rows of rods led to overheating with the downstream rows. Combustion efficiency fell off markedly as extinction speed was approached. It is concluded that cylindrical rods are unsatisfactory, but that further development of porous burner elements of non-circular section fed internally with fuel under pressure may be worth while. Difficulties may be experienced due to blockage by fuel-borne solids and by the formation of carbon on the downstream surface of the elements.

Work Study in Germany: A Report of the Activities of R.E.F.A. By L. J. HARPER. Note No. 32. (5*s.*) The report deals with impressions received during a visit to the R.E.F.A. Organisation (now known officially as Verband für Arbeitstudien), the German national work-study organisation. It covers training methods; the work of the headquarters staff; practices in three German factories—Mence and Hambrock, Altma, manufacturers of earth-moving equipment; Biersdorf Chemical Works, Hamburg; and Bergerdorf Eisewerke, Bergerdorf, manufacturers of refrigerators, dairy plant, textile machinery and other heavy plant; and research at the Max Planck Institut. The conclusions are that R.E.F.A. is not taking full advantage of its opportunity for standardising practices and procedures. The research establishments, on the other hand, have much to teach the United Kingdom.

Proceedings of the Second Work Study School Conference, Cranfield, 1955. Edited by L. J. HARPER Note No. 28. (5*s.*) Six papers by ex-students of the Work Study School were presented at the second conference: The Human Problems of Modernisation; Exhibiting Work Study; Work Study Applications in the Clerical Field; The Introduction of Materials Handling Schemes; Stores Codification as an aid to a Maintenance Incentive Scheme; and The 100 per cent. Standard.

Automotive Transmissions and Power Trains: Construction, Operation and Maintenance. By WILLIAM H. CROUSE. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (5.75 dols.); *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (43*s.*)

This book is one of a series of five books which cover automobile engineering in detail for the education of the automotive mechanic. It deals with clutches, transmissions, fluid couplings, torque converters, and various types of automatic transmission.

Soil and Water Conservation Engineering. By RICHARD K. FREVERT, GLENN O. SCHWAB, TALCOTT W. EDMINSTER and KENNETH K. BARNES. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (8 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (64*s.*)

This book covers all phases of soil and water conservation engineering. It includes information on hydrology, soil physics, erosion and its control, earth dams, flood control, irrigation, terracing, and legal aspects of conservation. It is intended as a textbook for agricultural engineering students and for field use by engineers.

Handbook of Industrial Engineering and Management. Edited by WILLIAM GRANT IRESON and EUGENE L. GRANT. *Prentice-Hall, Incorporated, 70 Fifth-avenue, New York, N.Y., U.S.A.* (16 dols.); and *Bailey Brothers and Swinfen, Limited, 46 St. Giles High-street, London, W.C.2.* (128*s.*)

This book has been designed as a reference book for those who have been trained in various engineering fields, and are now engaged in management activities. In some 1,200 pages the text is laid out to facilitate reference to all matters of management practice. The subjects covered include: managerial economics; engineering economy; manpower management and employment relations; time and motion study; factory planning and materials handling; industrial standardisation; tool engineering; industrial safety and hygiene; industrial budgeting; and trade unions and industrial engineering.

Theory of Ordinary Differential Equations. By EARL A. CODDINGTON and NORMAN LEVINSON. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (8.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (64*s.*)

Appreciation of this book requires a knowledge of matrices and of the essentials of the functions of a complex variable. The authors cover the existence and uniqueness of solution, linear differential equations, linear systems with isolated singularities of the first and second kinds, asymptotic behaviour of linear systems containing a large parameter, self-adjoint eigenvalue problems on a finite interval, oscillation and comparison theorems for second-order linear equations and applications, singular self-adjoint boundary-value problems for second-order and nth-order equations, algebraic properties of linear boundary-value problems on a finite interval, non self-adjoint boundary-value problems, asymptotic behaviour of non-linear systems (stability), perturbation of systems having a periodic solution, perturbation theory of two-dimensional real autonomous systems, the Poincaré-Bendixson theory of two-dimensional autonomous systems, and differential equations on a torus.

Welding Techniques and Uses in the U.S.A. Technical Assistance Mission No. 143. *Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris 16e.* (350 francs); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (7*s.*)

The report describes a visit by members of the International Institute of Welding to the U.S.A. to examine welding processes and research facilities. It is divided into sections on research, technical education, inspection, new processes, structural welding and handling devices.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Hydraulic Lift Trucks. CLARKE ELLARD ENGINEERING CO. LTD., Works-road, Letchworth, Herts. Lift trucks models F 1000 and F 600 to lift respectively 1,000 and 600 lb.; hydraulic lifting ram operated by pedal, maximum lifting height 5 ft. in both cases; B 1000 lift truck lifting 1,000 lb. through 5 ft. in 30 seconds powered by battery-operated 12 volt electric motor; hydro-electric luffing jib crane, capacity 5 cwt. at end of jib, hydraulic ram operated by battery-powered 24 volt electric motor. Illustrated leaflet.

Dust Extraction. W. C. HOLMES & CO. LTD., Turnbridge, Huddersfield. Holmes-Schneible multi-wash system for collection and cleaning of dust-laden gases and fumes; HC, IC and JC collectors made in 1,000 to 40,000 c.f.m. capacities and multiple units; settling equipment, rectangular, conveyor, hopper, and concrete type tanks; the Schneible velocitrap; various hoods. Illustrated booklet.

"The Story of Bruce Peebles." BRUCE PEEBLES & CO. LTD., Edinburgh 5. A history of the firm since it was established in 1866 for the manufacture of gas appliances. Special reference to the founding of the East Pilton works 50 years ago for the production of rotating electrical machinery, to which transformer, rectifier and welding departments have since been added. Illustrated booklet largely in colour.

Elastomer Sealing Material. EDWARDS HIGH VACUUM LTD., Manor Royal, Crawley, Sussex. Elastomer O-rings, sheet and tubing for vacuum sealing. Rings ranging from 0·114 in. internal diameter to 10·975 in., tubing from 4 mm. bore to 20 mm., and sheet from $\frac{1}{32}$ in. thick to $\frac{1}{16}$ in. thick. Leaflet C107/4 also gives groove sizes.

Platform Trucks. J. COLLIS & SONS, LTD., Regent-square, Gray's Inn-road, London, W.C.1. Hydraulic and assisted-leverage platform trucks with capacities up to 7 tons. Hand operated. Illustrated booklet gives various models and also the special platforms for these trucks. (This corrects the paragraph in our issue of July 22.)

Rotary Blower. W. C. HOLMES & CO., LTD., P.O. Box B7, Turnbridge, Huddersfield. RBS type Holmes-Connersville positive displacement rotary blower for pressure or vacuum applications; against 4·9 lb. per square inch pressure absorbs 17 h.p. with speed 600 r.p.m., air intake 420 cub. ft. per minute. Illustrated leaflet.

Electric Lamps. STELLA LAMP CO. LTD., 37 Oxford-street, London, W.1. Prices of incandescent lamps, fluorescent tubes, traction lamps, pigmy sign lamps, neon indicator lamps, miniature and automobile lamps and other lamps for special purposes. Also fittings and control apparatus. Illustrated catalogue.

Nylon Rod. HERCULES POWDER CO. LTD., 140 Park-lane, London, W.1. Akulon nylon-rod for industrial purposes, and injection and extrusion moulding. Sizes from 0·23 in. to 3·15 in. diameter in metre lengths. Booklet gives properties and advice on machining, etc.

Fuel Hose. CREATORS LTD., Plansel Works, Sheerwater, Woking. "Armourvin" general-purpose industrial fuel hose steel-spring with reinforcing built into tube wall; temperature range − 40 to + 70 deg. C., working pressure 350 lb. per square inch, bore sizes $\frac{1}{4}$ in. to 2 in. Illustrated leaflet.

High-Power Air-Cooled Broadcasting Transmitters. MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford. Full technical details of the high-power air-cooled broadcasting transmitters manufactured, with dimensions, figures of performance and valve schedules. Illustrated booklet.

Vacuum Unions. EDWARDS HIGH VACUUM LTD., Manor Royal, Crawley, Sussex. Flanged joints from $\frac{1}{2}$ in. to 2 in. and screwed unions from $\frac{1}{8}$ in. to 2 in., O-ring sealed for high vacuum work. Leaflet C 124/1.

Coal Pick. CLIMAX ROCK DRILL AND ENGINEERING WORKS LTD., 4 Broad-street Place, London, E.C.2. The SW. 2B pick, water controlled, designed to promote dust suppression in mines. Illustrated leaflet.

Test Equipment. FOSTER TRANSFORMERS LTD., South Wimbledon, London, S.W.19. Equipment of all types for high and low voltage testing of electrical apparatus. List FM17.

Movable Lighting Fittings. JOHN DUGDILL & CO. LTD., Hazel-grove, Stockport. Movable, focusing, self-sustaining, lighting fittings for fastening to ceiling, wall or work-bench. Illustrated catalogue.

EFFECT OF TURBINE ENGINES ON AIRCRAFT DESIGN*

FACTORS WHICH MAY INFLUENCE FUTURE TRENDS

By William J. Strang, PH.D.

Gas turbine aircraft are most economical if they fly fast, and from this fact stem most of the special features of turbine-engined transports. This paper begins with a description of the kinds of gas turbine engine used in aircraft, and then shows briefly why such aeroplanes do fly fast. Finally, a rather more detailed account is given of three design problems of special interest. To avoid tedious repetition, it should be said at once that many of the statements made need to be qualified by reservations and exceptions, which have been omitted in the interests of clarity and brevity.

TURBO-PROP VERSUS TURBO-JET

Common to all aircraft turbine engines is an arrangement of air intake, compressor, combustion zone, and primary turbine constituting the gas generator (Fig. 1). The output of the gas generator is a stream of gas possessing available energy in the form of heat, pressure and velocity. This energy derives from the heat energy released by the fuel burnt, and the thermal efficiency of the transformation depends on the engine design. Good thermal efficiencies require efficient components, a high working temperature, and a high pressure ratio. Some of the latest engines have two independent axial compressors in series, each driven by its own turbine (Fig. 1*b*). Such engines are said to be of two-spool design, and can use higher pressure ratios than single-spool engines can. In forward flight, some initial compression is obtained by slowing down the air entering the intake, so that the thermal efficiency improves with increasing forward speed.

The different types of turbine engine are distinguished by the means employed to convert the gas energy into useful work in propelling the aircraft. The simplest method is to employ a nozzle designed to eject the gases with the greatest possible momentum (Fig. 2). The resulting engine—the turbo-jet—is the simplest, lightest and most compact of the gas turbine family, but the efficiency of conversion of gas energy into thrust is low because of the large amounts of kinetic energy wasted in the high-speed jet. The efficiency improves with increase of flying speed, which is one reason why it is economical to fly fast on turbo-jet engines.

Another way to improve propulsive efficiency is to reduce the exit velocity of the jet. This can be done by accelerating a larger quantity of air to a lower velocity. In this way the thrust, which is measured by the change in momentum, can be maintained, while the wasted kinetic energy, which is measured by jet speed squared, can be reduced. In the turbo-prop engine, energy is extracted from the jet by additional turbine stages and used to drive a conventional propeller (Fig. 3). The total air flow may be increased a hundredfold and the result is an engine in which greatly improved fuel consumption and take-off thrust are obtained at the expense of increased weight and complication.

* Paper entitled "The Effects of Turbine Engines on Civil Transport Aircraft" read before Section G of the British Association at Bristol on September 6, 1955. Abridged.

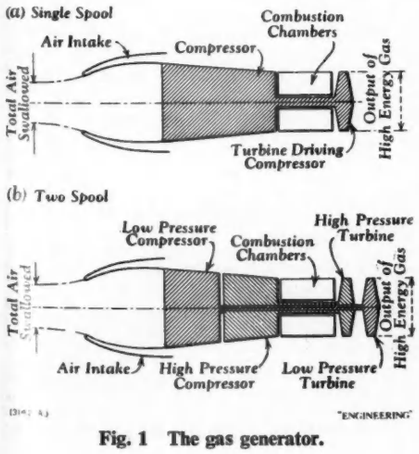

Fig. 1 The gas generator.

BY-PASS ENGINE

There is a range of compromise engines between the turbo-jet and the turbo-prop. The simplest of these is the by-pass engine (Fig. 4), in which part of the main compressor is enlarged, and the extra air is mixed with the primary air in the exit nozzle. The method is restricted by practical limitations of compressor and turbine design, and by-pass engines closely resemble jet engines in their characteristics. Small, but worth-while improvements in fuel consumption and take-off thrust are obtained at the expense of increased engine size.

The ducted-fan engine is a development of the by-pass engine in which reduction gearing is introduced into the drive to the enlarged compressor. It would be possible to design such an engine to have characteristics anywhere between the turbo-jet and turbo-prop extremes, but current thinking suggests an engine in which the air mass flow is roughly trebled. Such an engine remains a close relative of the jet engine, and it is probably an ideal engine for transports in the 500 to 550 miles per hour class. Because of lack of ducted-fan engine development, these aeroplanes are now proposed with jet engines, and it is entirely possible that owing to their late start, and the comparatively small gains they offer, ducted-fan engines will be altogether lost as a type.

Another intermediate class of engine has recently been announced. This has been called a "supercharged turbo-prop." It is a two-spool engine in which the airscrew and power transmission are of normal size, but the gas-generator is unusually powerful. The result is a lightweight turbo-prop engine with a high power output at cruising speed and height. Fig. 5 is a rough indication of the cruising speeds and altitudes suitable for aeroplanes fitted with these engines.

OPTIMUM HEIGHTS AND SPEEDS

The design of a successful turbo-jet transport is an exceptionally difficult business, but it so happens that the main forces that drive the designer are easily understood. It is a characteristic of the jet engine that the thrust output and the rate of fuel consumption change quite slowly with changes in flying speed. If the height at which the engine is operated varies, thrust and fuel consumption change together, and are roughly proportional to air density.

Let us suppose that we have an aeroplane of fixed shape and weight, and a whole range of engines of different sizes that we can fit in it. At any height the aeroplane has a best flying speed. This speed increases with height, and the thrust required is the same at all heights. If we fit small engines, the thrust will only be available at low altitude, in high air density, and the speed will be low. If we fit large engines, the same thrust will be available higher up. The aeroplane will fly faster, but the fuel consumption will be about the same, so the aeroplane goes farther on the same amount of fuel. The remarkable conclusion is that by fitting larger engines the speed and fuel economy improve together, and roughly at the same rate, which turns out to be as the square root of the engine size. There is a limit to this process, which is reached when the flying speed is so high that the drag of the aeroplane starts to increase because of compressibility effects. This speed is likely to be between 500 and 600 m.p.h.

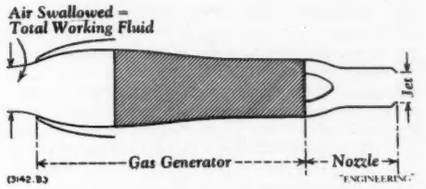

Fig. 2 Diagram of turbo-jet engine.

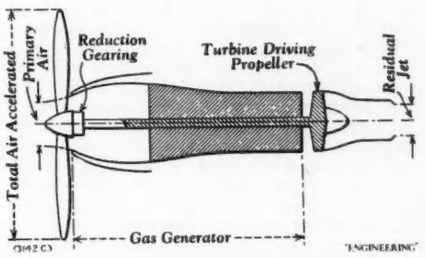

Fig. 3 Diagram of turbo-prop engine.

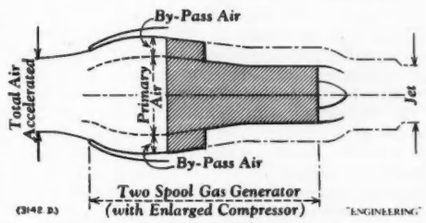

Fig. 4 Diagram of by-pass engine.

The cruising speed then is fixed within fairly small limits, and this fixes cruising height for a given shape of aeroplane. The cruising height for the same cruising speed can be altered by changing the wing loading. If the wings are made smaller, the appropriate height will come down, and smaller engines will then provide the thrust. The choice of cruising altitude is finally settled by the take-off and landing conditions. Short airfields mean big wings, big engines, and a high cruising altitude; long airfields mean small wings, small engines, and a lower cruising altitude. With airfields of the present size, the cruising altitude comes out at about 40,000 ft.

To summarise this section:—(i) For economy, turbo-jet aircraft must cruise as fast as possible; the limit is set by compressibility. (ii) To cruise fast, and operate from normal airfields, turbo-jet aircraft must fly high.

TURBO-PROP TRANSPORT DESIGN

Turbo-prop aeroplanes are under no compulsion to fly fast or high, but with conventional wing loadings they must fly high if they fly fast. Speed can be had at the cost of increased engine weight, and with engines of current design, cruising speeds between 350 m.p.h. and 400 m.p.h. seem best. The "supercharged turbo-prop," will lift this to about 500 m.p.h., when compressibility effects on airscrew tips may introduce a limitation.

The design conditions are less clear cut than in the turbo-jet case, and represent a balance between weight of engines and the economic worth of speed. A high cruising speed has sound economic value, the principal reasons being passenger appeal, and the simple fact that rate of earning is proportional to mean flying speed. If we take a conventional wing-loading of, say, 80 lb. per sq. ft., we have a fixed relationship between best flying speed and height, just as in

the turbo-jet case. The gas-generator size varies nearly as the cube of the cruising speed, instead of the square of the speed as in the turbo-jet case, and the take-off power output soon becomes unnecessarily big. It is therefore proposed to limit the size of the power side of the engine—heavy items like the reduction gearing and the airscrew—while the gas-generator size goes on increasing. The result is the "supercharged turbo-prop."

The implications of this development are still being worked out. The cruising power, and hence the economical cruising speed, can be increased for quite small changes in engine weight, and these changes are predictable. Airscrew efficiency is affected by fast cruising because the blades are travelling faster along their helical paths than the wing moves along its straight one, and so the blades enter the compressibility zone before the wing does. These changes are reasonably predictable, and are being steadily postponed to higher and higher speeds. When these effects, and many others such as the change in thermal efficiency with flying speed, are taken into account the conclusion is that we can make a turbo-prop aeroplane lighter for a given task than a turbo-jet up to about 550 m.p.h. cruising speed.

This result is so surprising that one looks for the snags. The first of these is that turbo-props of the right kind are not yet available. Turbo-jet development has out-stripped turbo-prop development and it will be three or four years before the comparison I have made will be valid. The second difficulty is noise. To a ground observer, turbo-prop aeroplanes are very quiet, and turbo-jet aeroplanes almost unbearably noisy. Inside the aeroplane, it should always be possible to make a turbo-jet aeroplane quieter than a turbo-prop, because the airscrews are inevitably a source of noise and vibration. Both can be made quieter than piston-engined aeroplanes, and better than most forms of surface travel but it is difficult to be sure if this will still be true for turbo-prop aeroplanes cruising at more than about 500 m.p.h. Until we can be sure, we do not know whether turbo-prop aeroplanes will stop at 500 m.p.h. cruising speed, or rival turbo-jets over the whole speed range.

There remains a further consideration. The turbo-jet engine is simpler than the turbo-prop and much of the extra weight of the jet aeroplane is fuel. It can be argued that fuel is cheaper than engines, and on these grounds, the jet aeroplane can be defended against its lighter, more efficient, but more complicated turbo-prop competitor. The struggle between turbo-prop and turbo-jet divides the aircraft industry on both sides of the Atlantic, and I have mentioned only a few of the points under debate.

The remainder of this paper deals in more detail with three design problems which I have selected. They are: wing design, which is affected chiefly by the high cruising speed; certain lift aids, which are made practical by turbine engines; and pressure-cabin design, which is a problem arising from high flying.

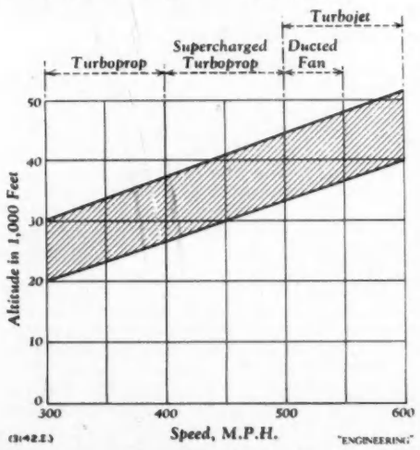

Fig. 5 Cruise speed and altitude relationship.

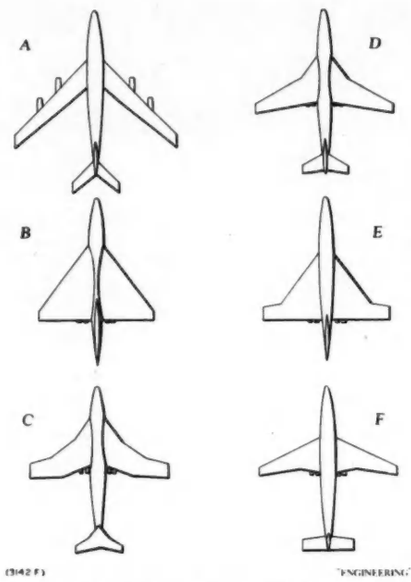

Fig. 6 Wing planform design.

WING DESIGN

Piston-engined transports, especially the long-range ones, all have very similarly shaped wings. The aspect ratio (ratio of wing span to mean chord) is usually about 10, and the average thickness of the wing is usually about 15 per cent. of the chord. Such a wing is very suitable for present-day turbo-prop aeroplanes such as the Viscount and the Britannia and for speeds up to about 420 m.p.h. no better wing shape is known.

If we try to push the cruising speed still higher we encounter what are known as compressibility effects, a term covering a large class of phenomena. The cause is simple enough. As the speed of flight increases, the pressure changes become more intense, initially as the square of the speed. At some speed, depending on the shape of the object in question, the pressure changes are big enough to make appreciable differences to the local air density—the air becomes compressed—and peculiar things happen to the airflow. Shockwaves form above the wing, and the airflow separates from the wing surface instead of sliding smoothly over it. The drag increases, and there may be vibration and loss of control.

Analysis of these changes is excessively difficult, although much can be learnt from high-speed wind-tunnel tests and the initial stages are mathematically predictable. The result, as far as this paper is concerned, is that the wing design must be changed before the cruising speed can be increased. The most straightforward change is to make the wing thinner. By reducing the wing thickness to about 10 per cent. of the chord, the cruising speed can be raised to about 500 m.p.h., and this may prove a very suitable wing for the next series of turbo-prop aeroplanes.

Most of the big jet aeroplanes, bombers and transports, rely on sweepback to postpone the bad effects of compressibility to a high speed. Sweepback does this, but it brings with it a crop of additional problems connected with structural design, and with the stability and control of the aeroplane. A mass of literature, bewildering even to the expert, exists on these subjects, and new reports are being published all the time.

The state of mind of the aircraft industry itself is revealed by Fig. 6, which shows a selection of the wing planforms that have been proposed for large turbo-jet aeroplanes. It should make us very humble. A class of 12 year-olds would produce similar results in half-an-hour, and the uninformed must surely assume that these shapes have been light-heartedly tossed off as the expression of their chief designers' artistic feelings. In fact, five of the six have been sufficiently well supported to be built, at great cost. They are the outcome of thousands upon thousands of hours of hard thinking and hard testing. They have survived competitive, and sometimes bitter, technical argument and scrutiny; they all work, and no one is sure which is best. The variations arise because the design requirements conflict, and different design teams have varied the emphasis. We could not trace all the arguments in a year, but we can try to guess at the chains of reasoning leading to a few of the shapes, and this will have to serve.

One line of argument runs like this. A long, narrow wing—of high aspect ratio—is efficient, and sweep-back raises the permissible cruising speed. These are good things so we will have them both. It helps the structural design to place the engines well out along the span to relieve the bending due to the wing lift, and a clever designer has found that by hanging the engines below the wing on stalks he can improve the flying qualities. The result is aeroplane A in Fig. 6. Inspection of this suggests that it would be a much "cleaner" aeroplane if the engines were buried in the wing. This makes the wing thicker, at least locally, and to preserve the high cruising speed we must increase the sweepback and the wing chord. It is convenient to make the wing biggest at the roots, but then the engines, with their intakes and jet pipes, drive tunnels through the wing structure. This is serious if the wing has a big span but does not matter if the wing has a low aspect ratio and sharp taper. Such a wing is light in weight but aerodynamically inefficient because of the small span. There is a way out. By going to the limit (aeroplane B in Fig. 6), it becomes possible to dispense with the tail and make a beautifully clean delta-winged aeroplane with buried engines, no tail-plane, and only a rudimentary body. These are extremes. There is a range of intermediate solutions, while design E aims at preserving the good features of the delta while improving the inefficiently small span.

This is the disappointing story of our attempts to design wings for aeroplanes flying a little slower than the speed of sound. For supersonic transports it is possible only to guess. The indications are that supersonic transports, to be economical, will have to be very fast indeed; not just a little faster than sound, but three times as fast. They will cruise at least 10 miles high, and they will almost certainly have wings of small span. These wings, it seems, should be either straight or very much swept—perhaps in the form of a narrow-angle delta like a paper dart. These are guesses, but one thing is certain, their speed will be wasted unless the terminal arrangements keep pace.

LIFT AIDS

It has been known for many years that profound changes in the pattern of airflow around

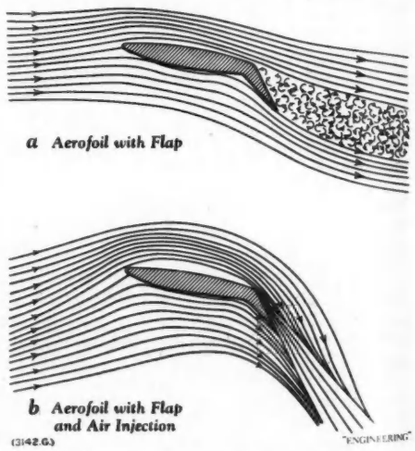

Fig. 7 Flow over aerofoil with flap.

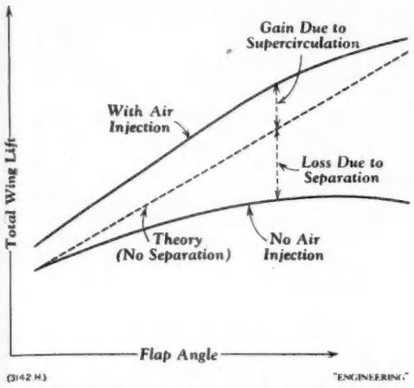

Fig. 8 Effect of air injection on wing lift.

a wing can be triggered off by injection of compressed air. Fig. 7*a* illustrates the air flow around a wing with a trailing-edge flap deflected. The purpose of the flap is to increase the wing lift, which it does; but its effectiveness is reduced by the separation of an eddying wake from its upper surface, so that the gain in lift is less than theory predicts. This separation can be prevented by a jet of air over the top of the flap, Fig. 7*b*, and the full theoretical lift increment might then be expected.

Fig. 8 shows that the air injection does indeed eliminate the loss, and adds some additional lift as well. This additional lift is due to a phenomenon known as super-circulation, and may be understood by supposing that the air jet entrains additional air from the main airflow, and accelerates it. The well-known Bernoulli theorem states that when the speed of a fluid is increased its pressure falls. The result is that the pressure over the top of the wing is reduced because of the acceleration produced in the main air flow, and this accounts for most of the extra lift. The two kinds of lift that air injection produces are quite different in character. The first kind, due to elimination of the air separation, is obtained quite economically, but it is limited in quantity. The second kind, due to super-circulation, is expensive but can be had in large amounts—several times the normal wing lift—if one is able and willing to pay the price in power.

One fascinating possibility is an aeroplane that can fly in its own slipstream. All aeroplanes with propellers gain additional lift because of the increased airspeed over the portion of wing behind the airscrews. It would be possible to design an aeroplane with light-weight turbo-prop engines, large flaps, and air injection which would be capable of hovering without the use of rotors. Control would be difficult, but such an aeroplane could be a rival to the transport helicopter. Immediate applications will be less ambitious. Air injection applied to an otherwise conventional aeroplane can be used to reduce the landing speed, and so improve safety and regularity in bad weather. It also reduces the speed required for take-off, but this does not always pay because the loss of engine power is usually enough to cancel out the gains. The "supercharged turbo-prop" is an exception here, because it has gas-generator capacity to spare for air injection.

Air injection is not the only way to control airflow. Strangely enough, sucking will do instead of blowing, and the turbine engine can be made to do this instead. Suction to improve lift uses less power than blowing does, but it is less positive in action, and the possible gains are smaller. Suction can be used to reduce drag as well as improve lift, and in fact it offers all sorts of fascinating possibilities which have tantalised designers for years without ever quite coming into fruition. If suction is more delicate than air injection, jet deflection is more brutal. It is nothing less than turning the main blast of the jet engines downwards. If the engines are sufficiently powerful the whole aircraft may be lifted bodily, but transport aeroplanes cannot use such big engines unless they fly very high indeed, and then, of course, they could take off and land quite well in the normal way. As usual, moderation is more likely, and this takes the form of deflecting the jets downwards at an angle, so that the weight is only partially supported by jet deflection. The take-off and landing are then normal in appearance, but slower.

All these devices for making aeroplanes fly more slowly increase the difficulty of providing satisfactory control, and if this is not dealt with the pilot's job might get more difficult instead of becoming easier. Fortunately, air injection improves control effectiveness; and this will probably be enough for all moderate applications of these new lift aids.

PRESSURE CABINS

At a height of 8,000 ft. the air pressure has fallen to 10·92 lb. per sq. in., about 74·2 per cent. of its value at sea-level, and this is acceptable. Passenger-carrying aeroplanes flying higher than this are pressurised, and the cabin structure must be designed to withstand the pressure difference. Fig. 9 shows how this varies with aeroplane altitude. A pressure difference of 10·92 lb. per sq. in. is enough to maintain 8,000 ft. cabin altitude at any height whatsoever.

It should not be thought that pressure cabins are novel, or peculiar to turbine-engined aeroplanes. All the long-range passenger aeroplanes in use to-day are piston-engined, and all are pressurised. The pressure difference of 7 to 8 lb. per sq. in. is suitable for turbo-prop aeroplanes, and 8 to 8½ lb. per sq. in. is sufficient for turbo-jets, so that turbine-engined aeroplanes are not very different in this respect from the latest types of piston-engined aircraft. Nevertheless, the pressure cabin is an essential part of the turbine-engined transport and the associated structural problems must be solved. Most people have heard of "high level" fatigue and know that it is a disease to which pressure cabins are subject.

Metal fatigue is not novel either; several disasters have been attributed to wing fatigue failure. It is reasonable to inquire if there is some fundamental difference between pressure-cabin design and wing design which makes one problem more acute than the other. The difference lies in the type of loading to which these items are subjected. A wing is designed to withstand the most extreme loading it is likely to encounter—for example, a severe manoeuvre or a violent gust—and in normal use only a

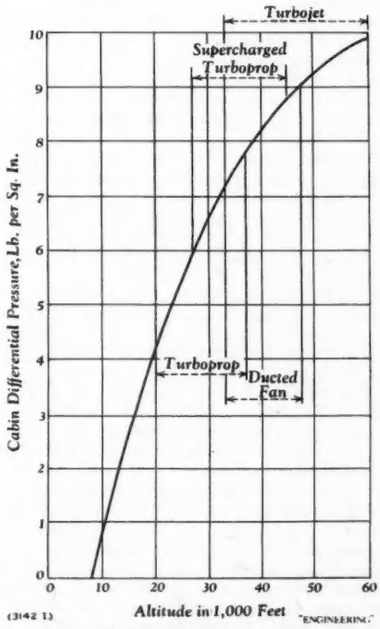

Fig. 9 Cabin differential pressures.

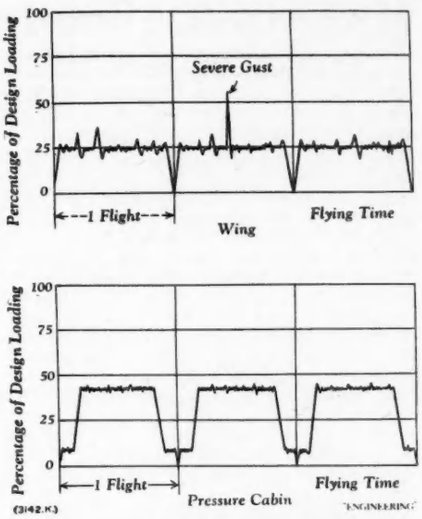

Fig. 10 Loading diagrams for cabin and wing.

fraction of this strength is required. The normal stress level, then, is small compared with the stress at the design load, and this provides some protection against fatigue failure. We know this protection may not be sufficient but it helps.

The biggest single contribution to pressure-cabin loading is the pressure itself, and this is controlled, known, and occurs on almost every flight. Something quite close to the design load occurs regularly, and fatigue considerations dominate strength requirements. A rough representation of the two kinds of loading is shown in Fig. 10, and it will be seen that whereas wings undergo many fluctuations of load well below the design level, pressure cabins have a regular cycle of loading near the design level, with small fluctuations superimposed.

Pressure-cabin structural design, then, is principally a matter of fatigue, and we know that in securing a good fatigue life it is important to avoid structural discontinuities, such as notches, cut-outs and changes in thickness. Such cut-outs have been studied and it has been found that, by careful shaping of the holes and suitable reinforcement around the edges, their bad effect can be minimised. The success of these adaptations is measured by the "stress concentration factor," which is the ratio of the maximum stress in the neighbourhood of the cut-out to the stress in the unperforated sheet. Perfect design, in this sense, would give a stress concentration factor of one.

A suitable analogy is a pneumatic tyre. As normally inflated, such tyres leak when punctured, but the damage does not spread. An over-inflated tyre may split or explode if punctured, and so may a normally inflated tyre if the initial damage is a sufficiently large cut. Pressure cabins may behave in either of these ways. A cabin of very efficient structural design is usually of the explosive kind, but may be acceptable with certain safeguards. If carefully maintained it should give a long period of safe service, and its eventual failure from fatigue can be forestalled by insisting on its replacement after a prescribed period of use.

Without doubt, a high standard of safety can be obtained with this type of pressure cabin, but the more attractive idea of a pressure cabin that will "fail safe," that is, leak harmlessly, is the subject of an increasing amount of research. Cabins of this kind are heavier, and this fact must be accepted. Two questions are of great importance. The first relates to the alloys of construction; metallurgists are asked to provide materials with properties not previously emphasised sufficiently—ductility, fatigue life, and resistance to tearing. The second is the general question of just how to design structures which fail safe, wherever the initial damage may happen to be located.

MANAGERS PEER INTO THE FUTURE

EFFECT OF NEW METHODS AND MATERIALS ON INDUSTRIAL GROWTH

Nearly nine hundred people from industry, research and the public services and a number of foreign visitors imbibed the bracing air and sulphurous fumes of Harrogate at the British Institute of Management's annual national conference held from Wednesday, November 2, to Friday, November 4, on the general theme of "The Impact of Science on Management in the Future." In fact, three themes could be distinguished among the papers and the panel discussions which occupied most of the time of the conference: the application of the scientific method to management, the brave new world of new materials and new methods which the scientist is making possible, and the human problems of training and management which the new techniques are going to create and new discoveries in the social sciences may help to solve.

The scientific method involves the collection of economic and technological intelligence, their combination with market research in the preparation of forecasts, and the consequent preparation of plans for optimum output from minimum resources. As Mr. C. P. D. Davidson, of Joseph Lucas (Electrical), Limited, said in his paper "The Combination of Economic Trends in the Preparation of Forecasts," forecasting is to selling what strategy is to tactics. To carry out forecasting it has been found necessary to employ a team consisting of an economist, a technologist and a statistician and it must have access to management thinking. The economist must not only study the future intentions of his firm's customers but, if concerned with exports, the effects of economic changes in other countries. The advent of automatic machinery involving heavy investment in special equipment will intensify the need for a clear picture of the future. Mr. D. J. Liston, of the Metal Box Company, Limited, who presented a paper on "Economic Statistics—A Guide to Management Decisions," also drew attention to the need to take account of national and international economic events when planning for the future. This is not only for sales purposes, but also to ensure that development plans do not outstrip sources of supply of raw materials.

OPTIMUM SPARES AND STOCKS

The preparation of plans from such information involves management decisions, but these decisions are more likely to be the correct ones if the manager can employ the scientific methods of operational research to arrive at the best result. In his paper "Operational Research—The Front-Line Scientist in the Management Team," Sir Charles Goodeve gave examples of the use of these methods, such as the determination of the optimum numbers of spares or the best level of stocks. One example is that concerning the bringing of foreign ore into British ports. Ships arrive at random and sometimes in bunches and have to wait to go alongside the unloading berths. On the other hand, at times no ships are available at all and the expensive loading equipment and the men are idle. These two losses have been balanced against one another and the analysis showed that the optimum condition is reached when the unloading equipment is of big enough capacity so that it is utilised for only 50 per cent. of the time. The capacity of nearly all the port equipment in Great Britain is so small that it needs to be put to use for at least 75 per cent. of the time, with consequent delay to ships. In nearly all operations things do not happen to a schedule; there are various degrees of randomness and that is something which has to be dealt with scientifically if progress is to be made. Examples are the arrival of aeroplanes at an airport or of mail orders at a stores and the sizes and qualities produced in a manufacturing process.

Making the necessary statistical calculations is becoming easier owing to the development of electronic computers, as the conference was reminded in a paper, delivered with his usual wit, by Dr. B. V. Bowden, on "Electronic Processing of Data for Management." He gave examples of some important calculations made during the last year or two on British-made computing machines. A large firm has eight factories and sells a product in bulk through 56 depots; the total output of each factory is known, and the cost of shipping from each factory to each depot. Which factory should supply which depot in order to minimise transport costs? This kind of problem can be solved by what is known as "linear programming."

STATISTICAL FORECASTS BY COMPUTERS

The given problem involved 64 equations with 448 variables and was solved by Ferranti Limited on the Manchester computing machine. One company which machines about two million pieces a month of 18,000 different patterns now schedules all its production automatically by this method. Decisions of this type have been called "sub-decisions" as distinct from policy decisions, but such policy problems as the right mixture of products for maximum profit in a factory, or even on a farm, can be determined in a similar way. A farm problem of this kind, involving 26 variables and 30 restrictions, was solved for the Department of Economics at Cambridge. The Douglas Aircraft Corporation of Santa Monica chose between a number of Government contracts which they were offered, so as to use their resources of plant and staff in the most profitable way, after a machine calculation involving half-a-million multiplication sums.

Machines of this type, used also for normal office work, will give great competitive advantages to their owners, but it is likely to cost far more to learn to use a machine in an office than it costs to buy the machine. Short courses on operational research are now being held at Birmingham and Nottingham Universities.

The new methods of manufacture were brought vividly home by the amazing and youthful Mr. John Diebold who, in his paper on "Automation," emphasised its use as a means of analysing, organising and controlling production processes to achieve optimum use of all productive resources—mechanical and material as well as human. There is a good deal of scepticism about the use of this word which has been popularised by Mr. Diebold himself, but in the course of a gruelling couple of hours he produced, in answer to questions, a very large number of examples from his own experience to illustrate what he believes it should mean.

DESIGN NO LONGER LIMITED BY HUMAN SKILL

In his view, the heart of the matter is the fact that, with the introduction of the new concept and the technology of self-regulating systems, it is no longer necessary to design the production processes around the limitations of human skills. Before applying these techniques a most careful analysis is required of every aspect of product design and the method and purpose of every aspect of the manufacturing process. The timing of its introduction is also of importance as well as the cost of planning, training, breakdown and maintenance time and wastage.

The factory must be organised for basic change involving top-management decisions, and for this purpose it is necessary to set up a special group inside the firm reporting to the head of the engineering or production department. In this connection it was interesting to learn, during the discussion of Dr. Bowden's paper, of the practice of two British firms. The British Motor Corporation have set up a team consisting of the chief electronics engineer, an accountant, and a leading production-planning engineer; while Courtaulds have one consisting of three accountants and one operational research worker.

MACHINE CONTROL BY NUMBERS

Mr. Diebold said that there were in the United States already 30 projects for the numerical control, through computers, of machine tools, a large number of them having been developed by the users themselves. Their advantages were that they were capable of a greater co-ordination of motions than was possible by hand, so that surfaces could be generated of a type not previously possible.

In explaining the high cost of adding electronic control equipment to standard machine tools he said that at least one third of the basic cost of the machine could be saved if the machine is designed round the equipment. For instance a turret lathe costing 25,000 dols. can be made for 7,500 dols. less when re-designed to receive numerical control equipment; making a total cost of 30,000 dols to 35,000 dols. It is now possible to make cheap and flexible electronic machine tools.

Mr. Hymans, a Dutch consultant, described similar work done in Holland and about to be put on the market by a French firm. The first machine will be a universal milling and drilling machine and there will also be equipment for building into custom-made machines. A large capital investment would not be needed; a lathe could be equipped for about £2,500.

One of Mr. Diebold's most interesting statements was that the number of employees was no criterion for the introduction of automation. The process industries were among the most inefficient; oil refineries, for instance, rarely operated for more than two or three minutes a day at optimum efficiency of utilisation of raw materials.

COMPLAINTS

The usual complaint, voiced also on this occasion by Sir Walter Puckey, was heard about the lack of collaboration by the machine-tool makers themselves, and it was interesting to hear Mr. Diebold say that it was the same in the United States where, according to him, the machine-tool industry was "very stagnant." This criticism was also strongly heard during a depressing panel discussion on "The Impact of Scientific Development on the Tools of Production," which was distinguished by the fact that three "user" representatives on the panel, a marine-engine builder, a motor-part maker and an elastic-cloth weaver, each separately demanded the abolition of import duties on machinery so that they could buy abroad. The engineers were, however, much less dissatisfied than the textile manufacturer, who implied that modern machinery suitable for the new synthetic fibres was best obtained in Switzerland.

Complaints of inadequacy of research work, lack of interest in user's requirements, early breakdown after installation (including German plant) and poor after-sales service (particularly of instruments) were voiced by representatives of a number of industries in a discussion that looked backward much more than it looked forward. It was unfortunate that there was only one representative of the machine-tool manufacturers—Mr. H. P. Potts of B.S.A. Tools, Limited, and President of the Machine Tool Trades Association, who was a member of the panel—and that there was no textile-machinery manufacturer at the conference. One question asked about the machine-tool industry was what its customers could do to make it take a less cautious view of the future and expand its productive capacity and become more versatile.

MADE-TO-MEASURE MOLECULES

By contrast, a panel discussion on "Revolutionary Developments in Materials and Processes" produced some relatively interesting information, perhaps because it was introduced by scientific representatives of some of the new

chemical and metallurgical industries. As described by Dr. V. E. Yarsley, an independent consultant, the new industrial revolution will be based on an alliance of chemically-based energy through the splitting of atoms and chemically-based raw materials formed by joining atoms together to form the giant molecules of made-to-measure substances.

Dr. M. A. Matthews, of the Shell Petroleum Company, Limited, gave figures of the accelerating growth in the production of organic chemicals and particularly of those based on petroleum. He foresaw an expansion in this country during the next decade of petroleum-based products from the present 27 per cent. of total output to the American figure of 70 per cent. The quality of petroleum was more constant than that of other raw materials and it was likely to be more and more reserved for chemical manufacture as nuclear power became available.

RED-HOT SPRINGS

Mr. D. A. Oliver, of B.S.A., Limited, mentioned a new rhenium-cobalt alloy for very small springs capable of retaining its elasticity while red hot. Owing to the growing shortage of nickel, titanium might take the place of stainless steel, since it was more resistant to corrosion, although difficult to weld and expensive. He also described the progress made in Germany in the vacuum casting of large steel ingots, with the consequent exclusion of hydrogen and other gaseous impurities. This was of particular value for the forging of large electrical rotors which are highly stressed, and in the manufacture of ball bearings of high reliability.

It was unfortunate that Professor George Homans, the eminent Harvard sociologist, at present visiting professor at Cambridge, was prevented by illness from presenting his paper. He had intended to emphasise the immaturity of his subject and the difficulty of using it to answer the questions that management often wants to ask about the human problems with which it has to deal. It would have been interesting to have heard a discussion between him and Dr. A. T. M. Wilson of the Tavistock Institute of Human Relations, who gave a paper entitled "Some Contrasting Socio-Technical Production Systems", or Professor T. S. Simey of Liverpool University, who, in a panel discussion on "The Human Implications of Technical Innovation," said that sociologists had learnt a lot in the last 25 years; but much that could have been, had not been applied in industry.

MORALE AND TECHNOLOGICAL CHANGE

Dr. Wilson described three studies, in shipbuilding, in coal-mining and in weaving, to illustrate his theme that bad morale or resistance to technological change may largely reside in resentment over the imposition of new forms of work organisation which, by their formal structure, unwittingly inhibit even the informal development of the minimum psychological and sociological conditions necessary alike for productive efficiency and satisfaction of basic human needs.

In the panel discussion Mr. K. D. M. Dauncey, of the Steel Company of Wales, Limited, pointed out the difficulties that technological changes may create not only in wage differentials but also in social relationships. They often affect personal prestige and the social structure in the community outside the factory.

The importance of confidence in the competence of management to maintain employment, especially during the inevitable initial difficulties, was stressed. Mr. W. J. Carron, of the Amalgamated Engineering Union National Executive Council, said there would be no opposition from the trade unions to changes provided that full account was taken of their social effects, including those on health, and that the unions were fully consulted beforehand. He reminded his hearers of the bitter memories of past changes and of the fear of what he called "pie in the sky" promises about future benefits. In referring to the social effects of large changes he mentioned the break-up of Woolwich Arsenal, round which a whole community had developed. To deal with changes on that scale were beyond the compass of industry itself. Other trade-union speakers expressed similar views. There were a number of other papers and discussions as well as lectures by Sir Harold Hartley and Mr. Graham Hutton, both of which have been reported in the daily Press (Mr. Hutton's lecture was mentioned in our Human Element columns last week).

The value of such a conference will be different for different people. Most of those who attended appeared to have acquired some new information, generally of a technical nature; but it seemed that it was the opportunity to meet and exchange ideas, either in the informal discussion groups held on Thursday evening or in the Royal Hall, or in one of the hotels on the conference "campus," that was most appreciated. In this way the isolation of the average manager, especially in the smaller firms, can be broken down. Though he finds out that there is much of which he is ignorant, he also learns that his anxieties, as well as his ignorance, are not unique.

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FILMS AS AN AID TO MANAGEMENT

Productivity and Sales from an American Viewpoint

Three American industrial training films have recently been made available in this country by the G.B. Film Library. They deal with time and motion study, the fundamental value of selling in a democratic industrial society, and the planning and direction of inter-departmental conferences.

The first, entitled "The Foreman Discovers Motion Study," shows a group of foremen taking part in an experiment under the supervision of a methods engineer, and indicates how easier working and increased output can be achieved by systematic study of working procedures. The experiment involves the construction of small boxes, and narrative and feature techniques are employed to make the film both instructive and entertaining. Although photographic quality is not of the highest, the film is entirely convincing, and fully succeeds in conveying the message that motion study gives results. It was made by the University of California and runs for 20 minutes. (Catalogue number IF.3953.)

"The Importance of Selling" is an Encyclopaedia Britannica film and describes the rôle of the salesman in contemporary society. It emphasises the relation between selling and other aspects of business activity, outlining the structure of typical sales organisations, and draws attention to the part played by the salesman as a two-way link between maker and user. It also underlines the services provided by the salesman, pointing in particular to the work of the sales engineer. In general, the film, which runs for 20 minutes, lays stress on selling as a creative activity, creative because by generating demand the salesman has been responsible for the proliferation of industrial civilisation. Popularly, the salesman is the man who sells you something you don't need; in fact, he brings to light a need you never knew existed. (Catalogue number IF.3969.)

The last of the three films is called "All I Need is a Conference." The title should be uttered with a sigh for it represents the *cri de coeur* of a busy departmental manager, who at the height of a frenzied day is called to take part in a factory committee meeting. During the course of this amusing film a skilful chairman convincingly manages a group of barely compatible people, and guides each of them in turn into making a fruitful contribution, so solving the problem of unmet delivery dates and revealing a number of useful conference techniques. The film lasts for 30 minutes and was made by G. Henry Strauss and Company, Inc. (Catalogue number IF.3954.)

The hire cost of the first two films is £1 for the first day and 10*s*. for each subsequent day; and of the third, which is supplied with a handbook, £3 for the first day and £1 10*s*. for each succeeding day. They are all in black and white with sound and may be obtained from G.B. Equipments, Limited, Film Division, Aintree-road, Perivale, Greenford, Middlesex. Films are dispatched to arrive two days before the hire date so that they may be examined before being shown to an audience.

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PHOSPHORUS AND MELTING FURNACES

Report of Cast Iron Research Association

While the bulk of the phosphoric pig iron used in the iron and steel industry is manufactured from home iron ores, low-phosphorus and hematite cast irons, the demand for which is tending to increase, are produced mainly from imported ores. The question of phosphorus in cast iron has again been before the British Cast Iron Research Association and it is felt to be highly desirable that the Association should explore the technical possibilities of reducing the phosphorus content of native pig irons without loss of carbon, such as takes place in the basic Bessemer process. It is stated in the 34th annual report of the Association for the year ending June 30, 1955, recently issued by the Council, that a phosphorus panel has been formed of representatives of member firms and authorities having special knowledge and experience in this field. Certain aspects of the problem of sulphur in cast iron will also be considered.

A second major research project is concerned with furnace research, equipment for which, in any case, will be required for the work on phosphorus. A building for use as a melting research station has already been completed and pending the receipt of equipment it is being used for work on foundry atmospheres. It is proposed to install equipment to provide the whole of the molten metal required for the research and development programme. To it will be transferred the crucible furnaces now in use, together with a vacuum melting furnace and a high-frequency melting furnace. Space is also provided for a cupola melting furnace of special design. The vacuum melting furnace is to be a gift to the Association. It was the hundredth of its type made in Boston, U.S.A., and is to be provided through the International Cooperation Administration (formerly the Foreign Operations Administration) on the order of the Department of Scientific and Industrial Research. Its receipt and use, however, still remain dependent on the result of negotiations with the Board of Trade on the question of import duty.

In addition to the work on phosphorus, the furnace research equipment will be closely linked with other experimental work, now proceeding or pending, on gases, nucleation, slag-metal reactions and oxidation and de-oxidation phenomena.

Other researches now under way in the laboratories of the Association, at Alvechurch, Birmingham, are concerned with the soundness of iron castings, gases in cast iron, corrosion, methods of analysis and other matters, and very brief particulars on the progress made during the year are given in the report.

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GAS-TURBINE COURSES

The College of Aeronautical and Automobile Engineering, Chelsea, London, S.W.3, is to introduce courses in gas turbine engines for road transport and industrial uses.

Practical work, consisting of the complete dismantling, inspection, re-assembly, and testing of various types of gas turbines will be given and will be supplemented by lectures dealing with the basic principles of construction and operation.

Fracture of a rupturing diaphragm on a 60 MW steam turbine.

FRACTURING THE SAFETY DIAPHRAGM OF A STEAM TURBINE

The accompanying illustration shows a 66 MW steam turbine for the Wabamun station, Calgary, Alberta, Canada, undergoing tests at the Trafford Park works of the Metropolitan-Vickers Electrical Company, Limited. The tests included the deliberate fracture of one of the rupturing diaphragms in the turbine casing which, during normal operation, supports atmospheric pressure. Should excessive pressure develop in the exhaust space, however, such as might result from an interruption of the cooling water supply and a consequent loss of vacuum, the diaphragm, which is of sheet lead, is ruptured. The exhaust space is then opened to the atmosphere and the escaping steam is directed upwards. Damage to the machine is thus prevented.

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RESIN ADHESIVE AND CASTING MATERIAL

Bakelite, Limited, 12–18, Grosvenor-gardens, London, S.W.1, have recently issued information concerning their resin R 18774. This is a liquid epoxy resin, which when mixed with hardener Q 18964 forms a cold-setting adhesive, and when mixed with Q 18905, it is suitable for producing castings. The adhesive is suitable for bonding metals, polester/glass-fabric laminates, phenolic laminates and mouldings, glass, porcelain and wood. It may be extended before use by adding mineral fillers. Joints made with this material have good water resistance. Strengths of 1,450 lb. per square inch at room temperature rising to 2,400 when cured at 100 deg. C. can be obtained.

The casting mixture will harden at room temperature without excessive heat generation, but the complete castings should be stored at between 40 and 50 deg. C. for at least 6 hours. The most satisfactory method of production appears to be a two-stage process, in which a core with a high proportion of coarse filler is first cast and then faced to a thickness of about $\frac{1}{8}$ in. with a mixture of equal parts of resin and fine filler. Surface contraction during setting is negligible.

The Iron and Steel Institute Meeting in Scunthorpe (continued from page 631)

STEELMAKING AND STEELWORKS MAINTENANCE

We now continue our report of the special meeting of the Iron and Steel Institute held in Scunthorpe, Lincolnshire, from October 12 to 14. On the morning of the second day of the meeting, Thursday, October 13, two simultaneous technical sessions were held and we deal first with session "A" over which Mr. Cedric Thomas presided. During this session two papers were presented and discussed, the first being "Steelmaking at Redbourn," by Mr. S. R. Isaac, melting-shop manager at the Redbourn Works of Richard Thomas and Baldwins, Limited, and the second, "Organisation for Maintenance," by Mr. J. L. Gaskell, director and chief engineer of the Appleby-Frodingham Steel Company.

STEELMAKING AT REDBOURN

In presenting the first paper, Mr. Isaac stated that although there had been a Redbourn Works in existence on the present site since 1874, it was not until the latter part of 1918 that the production of steel had been put in hand. At present, the melting shop comprised seven fixed 120 ton basic open-hearth furnaces and one 500 ton mixer. Sufficient 120 ton casting ladles were not yet available, however, and 30 per cent. of the charges were still limited to 100 tons. This position would be rectified before the end of the present year when all furnaces would be charged for tapping 120 tons.

Over the years, much pioneer work had been done at Redbourn in developing the use of coke-oven gas for firing the steel furnaces, while a substantial contribution had also been made to the development of the all-basic furnace. The results with all-basic furnaces left no doubt concerning the increased rate of working that could be achieved. Heating up with big, heavy, partly-worn basic roofs, however, had been found to be a difficult task. By taking matters very steadily, it could be done, but the time taken reduced furnace availability and thus reduced the benefits of the increased rate of production. A compromise had now been reached: all the furnaces had been built with complete basic uptakes and ends, all-basic back and front linings, and a 42 ft. silica roof over the bath. This combination gave the best all-round refractory cost and permitted a good furnace availability (90 per cent.) to be maintained.

Pig iron formed the basis of the steel-furnace charge, and the furnaces worked with from 65 to 70 per cent. hot metal and 30 to 35 per cent. scrap. Unfortunately, the blast furnaces were not supplied with sinter but worked on a mixture of local ore plus Northamptonshire ore, together with a little foreign ore. In the not far distant future, however, the Redbourn furnaces should be working on a sinter burden.

A new de-siliconising plant had just been started up. The object of this plant was to allow the blast furnaces a little more margin in silicon, in the hope of getting a hotter clean iron lower in sulphur. Another object was to remove the silicon with oxygen, and at the same time, increase the heat content of the iron, thereby speeding up the melting and refining time in the open-hearth furnace. The first few days' results had been very promising.

During the last few years the output of the steel melting shop had steadily increased. Last year had been the highest to date, when 396,081 ingot tons of steel had been made. This year, up till July 23, 228,293 tons had been made and there was every hope that the year's output would reach 450,000 tons.

DISCUSSION

Mr. T. G. Grey-Davies, who opened the discussion, said that Mr. Isaac had stated that each year the scrap quality became worse from a charging standpoint. The time was long overdue for scrap merchants to get down to the task of producing scrap suitable for the ever-increasing melting rates of modern furnaces.

Steel men in Scunthorpe had their own private difficulties, but they had wonderful courage and ingenuity in altering their practices to meet the conditions. Mr. Isaac has done that with his de-siliconisation. Quite a number of South Wales plants used Scunthorpe iron, but, in addition, a fair proportion of imported iron—Russian iron with 2 per cent. of manganese and a low percentage of phosphorus, and also sulphur was utilised. The best results were obtained by taking 50 per cent. Scunthorpe and 50 per cent. Russian iron.

The de-siliconisation and de-sulphurising process had been developed at Redbourn to meet local conditions, and the money spent on the desiliconisation plant was certainly not being wasted. The melting-shop personnel, in general, must have welcomed it.

Furnaces in South Wales were changing over rapidly to oil fuel and making an increasing use of oxygen. At Ebbw Vale the whole plant was being changed over to oil.

One final point. The first hands on the melting-shop stage at Redbourn were very grateful for the instrumentation provided; they had found it to be an excellent guide.

In reply, Mr. Isaac said that, in many works the introduction of an innovation such as oxygen meters had been met with much distrust, but his men always agreed to give a new development three months' trial.

Coke-oven gas firing and oil firing were completely different from using producer gas. With producer gas a much lower sulphur content was obtained and this was further reduced because the gas was passed through regenerators and desulphurised there. The use of high-sulphur fuel, as well as the quality of the pig iron, could have a very material influence on the amount of sulphur which could be picked up.

REJECTING BAD SCRAP

Mr. Richard Mather said that no scrap merchant sent good enough scrap to the steelworks, and melting-shop managers must take a tough line with them. The material should be examined when it came into the works and if it were not No. 1 grade when the merchant said it was there should be no argument about it, and no claim for half-a-crown reduction should be made. The wagon should be returned and other works in the area should be told by telephone that wagon No. so-and-so, which was supposed to be No. 1 scrap, was not satisfactory and should not be accepted. If bad material were thrown back on to the scrap merchant, without any argument, eventually there would be much less to complain about and a general improvement in the economic operation of melting shops would result.

SUCCESSFUL SKIMMING

Dr. David Binnie said that, in the course of his paper, Mr. Isaac had stated that the hot pig iron was de-sulphurised with $\frac{3}{4}$ per cent. soda ash, skimmed, and put into the mixer. He (Dr. Binnie) would like to know how it was skimmed. A steel-plant manager did not want partially-skimmed slag, and the slag was not easily removed. Mr. Isaac's shop was one of the few which had been using soda ash for many years, apparently with satisfaction. Many shops, including that of the Lancashire Steel Corporation, had used it for a period quite successfully chemically, but the removal of the slag had "killed the process."

In reply, Mr. Isaac said that the first essential

to get a good skimming was to get the hot metal over quickly to the melting shop after casting. The soda ash was put in and there was little trouble in skimming because the slag was still molten. If, however, the metal became a little cool troubles arose and it was very difficult to skim adequately then.

ORGANISATION FOR MAINTENANCE

The second paper before session "A" was entitled "Organisation for Maintenance" and was by Mr. J. L. Gaskell, director and chief engineer of the Appleby-Frodingham Steel Company. He stated that the objectives of a maintenance organisation were to safeguard the buildings, plant and equipment in its care against undue depreciation or loss; to maintain these assets in a state of the highest efficiency; to eliminate breakdowns caused by fair wear and tear by replacing worn parts before they failed; to foresee potential failures; to repair accidental damage quickly; to expend the minimum amount of money in achieving the foregoing objects; and to avoid locking up excessive unproductive capital in unduly large stocks of spares.

In the metal industries the difficulties were intensified by some of the severest duties which could be imposed on industrial plant, such as abrasion in ore-preparation plants, corrosion in pig-casting plants, and shock loadings and frequent stress reversals in rolling-mill equipment. Moreover, increased mechanisation had resulted in the present position that the ratio of operational to maintenance labour was approximately 3 : 2.

The fundamental principle of the maintenance organisation at Appleby-Frodingham was a division into areas, each under a plant engineer. The plant engineering divisions were, respectively, ironworks mechanical, steelworks mechanical, and electrical.

Inspection was the basis of any methodical maintenance and daily running inspections and period inspections were carried out and records prepared and returned to the plant engineer.

Lubrication was an important aspect of maintenance activities and a specialist lubrication engineer was responsible for selecting and scheduling the lubricants to be used throughout the works. He advised as to their methods of application, investigated all problems arising from their use and was responsible for the economic re-use of lubricants removed from circulatory systems.

DIRECT OR CONTRACT LABOUR?

In opening the discussion Mr. H. M. Morgan said that the statement that appealed to him was the one that increased maintenance would result in an increase in the ratio of mechanical to operating personnel. He hoped that this would be noted because it was often the engineering personnel who felt the axe whenever costs had been more than they might be. He believed that Appleby-Frodingham employed quite a lot of outside contract labour, and it was stated in the paper that the machine shops worked virtually as a separate company, and that the whole of the structural maintenance was carried out by their associated constructional company. He would like to know whether that labour was included in the ratio of 3 : 2, given by Mr. Gaskell. He had been interested to read of three departmental engineers for 10 plant engineers, and to learn that one plant engineer has six assistants. He would like to know how far those assistant plant engineers were, in fact, fully-fledged engineers? Did the numbers include some trainees? A works of the size and importance of Appleby-Frodingham must have a regular flow of trainees.

There was no mention of boiler-shop labour. What happened when a burner or a welder was wanted quickly? He would also like to know whether the departmental maintenance shop was individually staffed, or how far they had got over the lines of demarcation.

He had no doubt that Mr. Gaskell was very proud of the results achieved by joint consultation, careful planning and the training of personnel. He would like him to tell the meeting whether he believed the spirit abroad to-day was the same as that which existed before 1939, or whether it had been necessary to employ additional labour or pay additional incentive bonuses.

Everyone would agree that the standard of maintenance and the appearance of the plant at Appleby-Frodingham was exceptionally high.

Mr. J. L. Daniel stated that the growth of maintenance organisation was, as Mr. Gaskell had said, bound up with increasing mechanisation, but it might be that firms were approaching the peak number of men employed on maintenance. The vastly improved design of various units of heavy iron and steel works equipment had a bearing on this question. Thus the modern blast-furnace top required practically no engineering maintenance between campaigns, other than repairs to receiving hoppers and chutes. There were further examples of improved design. At Stewarts and Lloyds Limited, Corby, there were units of plant, built in 1934, which had operated for the past 20 years with very small maintenance requirements. They formed part of the 42 in. and 32 in. reversing rolling-mill plants.

PLANT DEPRECIATION

The design of overhead cranes was receiving attention at the present time, and designers were at last becoming aware of the great abuse inflicted upon overhead stripping and charging cranes in steelworks.

The plain overhead crane could be designed to give long periods of trouble-free running. There were two 50 ton hot-metal ladle cranes in the Corby Bessemer shop, which had been built in 1943 and 1944, respectively. A breakdown of any description on either of these was a rare occurrence. He looked forward to the day when all overhead cranes were as well designed and generously proportioned so as to enable them to deal with the heavy duties entailed in the making of iron and steel. He also looked forward to the day when all rolling-mill equipment was so robustly and expertly designed that mid-week failures would be a thing of the past.

It had been stated that the ratio of operational to maintenance labour was approximately 3 : 2. Would Mr. Gaskell explain how this ratio was derived. Did the total of the personnel on works maintenance take in the central engineering shops, including locomotive repairs and wagon repairs? Furthermore, did it include bricklaying and general labouring, or was it solely in respect of maintenance fitters and electricians and their assistants?

The central engineering shops of Appleby-Frodingham had been mentioned as very important factors in the overall maintenance system. This brought up the old argument as to whether main spare parts should be purchased or manufactured within the company using them. In Corby few spares were made in the engineering shops. In fact, what was known there as the central engineering shop only carried out work consequent upon immediate or near-immediate requirements, breakdowns and certain items of work which it was deemed could be better done on the spot than elsewhere.

Not having the capacity for making spares on a larger scale at Corby, it became necessary to carry considerably higher stocks. The organisation and administration of the spares department were of great importance. This department was in the charge of an experienced senior engineer who had under him a staff of clerks and helpers who carried out the ordinary routine work of keeping records and the re-ordering of spares as they were used up by the various departments. The official re-ordering of spares, was, of course, carried out by the central buying department.

It was to be hoped that, at some time in the future, an opportunity would be found to discuss the kind of training required to make a good maintenance man.

Mr. Gaskell, in reply, said that contract labour was used a good deal at Appleby-Frodingham, in the present labour supply conditions. In the works as a whole, however, the use of this labour on maintenance work was pretty well confined to plate-laying. Contractors were also employed on new work. This labour was certainly not taken into account in the figures given in the paper. Contract labour was not taken into account in the ratio quoted but this did give an overall figure for the company as a whole, including the central engineering workshops. It took in the United Steel Structural Company and included also bricklayers and labourers. The division was between operating personnel and maintenance personnel, and if one admitted these definitions there could not be much argument whether a certain man was operative or maintenance. The ratio had also been confined to workmen. Staffing had been left out of consideration. The establishment of engineers quoted for Appleby-Frodingham Steelworks was the normal one and did not take account of trainees.

There were a couple of welders in the works; one man per shift. Burners were on the strength as well. All the fitters or turners were trained as fitter-turners. Incentive bonuses were paid. The erection of the slab shears for instance had been successfully achieved with the help of an incentive bonus.

Improvements in design were being effected all the time as opportunity for replacement arose. He also looked forward to the time when mid-week stoppages could be eliminated.

The question of how much was purchased and how much was made in the central engineering workshops was entirely a matter of economics. He very strongly supported Mr. Daniel's plea for an opportunity to discuss at length the very important question of the training of suitable engineers for the industry.

VALUE OF CENTRAL WORKSHOPS

Mr. J. H. Powell asked Mr. Gaskell whether he considered that the central engineering shop really did work. Did he get the repairs delivered at the right time, and when he got them did they fit? The greatest evil he had found in the industry was the wage structure of the craftsman. Generally speaking, the craftsman was not paid on an incentive plan. The maintenance man kept the mill going while another earned the money. The whole wage structure required immediate alteration. The status of the maintenance engineer must be improved and he should be paid more.

Mr. Gaskell, in reply, said that the question of the wage structure was outside the scope of his paper. It was a very big subject, and if Mr. Powell had any ideas on finding a better way of paying craftsmen the members would be very pleased to hear about it.

The central engineering workshop organisation certainly did work. Of course, there were instances of things being made which did not fit. The workshop probably did not get the right information in the first place. Mr. C. G. Oram, the manager of the central engineering workshops, was present and might like to add something.

Mr. C. G. Oram said that he must answer the challenge as to whether the central engineering workshops worked. They certainly did and he had figures to prove it. Their turnover for the first year was £500,000 and for this year it would be £1,250,000, with less personnel operating. They certainly made a thing fit. They had the equipment to measure the article and they produced it. He doubted whether deliveries outside could be obtained as quickly as they provided them. They had orders for about 400 a week, and these were dealt with fairly expeditiously. About 40 per cent. of his personnel was now engaged in producing new plant for replacements. He could say, with sincerity, that they were to time, and that was more than a great number of outside suppliers could claim.

To be continued

THE DIESEL ENGINE OF THE FUTURE

LONG SERVICE COUPLED WITH LOW RUNNING AND MAINTENANCE COSTS

In a paper entitled "Diesel Engines—Design for Service," which he presented to the Diesel Engine Users Association on October 20, Mr. C. H. Bradbury, M.I.Mech.E., M.I.Mar.E., the technical director of Petters Limited, Causeway Works, Staines, Middlesex, outlined various points of design which promote long service and minimum cost. Some of the points he mentioned are summarised in this article.

Though the capital cost of an engine is certainly important, in the long run the prime consideration of the purchaser is the cost of operation. Five factors make up the bulk of operating costs: (1) fuel and lubricating oil; (2) standing charges; (3) wages of staff; (4) repairs and replacements: and (5) depreciation. Of these, the last three may make up 35 per cent. of the total. Although in the early days the time for renewing a part was left to the user, nowadays tables of wear limits are provided, giving the amount of wear that can take place before the part should be replaced. Such a table is given here for an engine of 8½ in. bore.

When laying out a new engine, the designer has to consider the following four main points: (1) the duty to be performed; (2) reliability; (3) accessibility and ease of maintenance; and (4) ease of production and economy of materials. It should be noted that (4) affects not only the works production costs but also the limits of accuracy as determined by market price, the interchangeability of spare parts and the choice of a material which is suitable not only for long service but also for accurate production. An ideal engine might be one which was "self-cleaning" and which would give 25 years' service for the wear limits given in the table.

DETAILS OF DESIGN

As regards particular items, a few specific points are mentioned here, but it should always be remembered that overall reliability is the result of a combination of features of design embodied in correct proportions. A modification to improve one component may have disastrous effects on another; rigorous trials should therefore be made before any basic change is accepted as standard.

Filters.—Adequate filtration is needed at the air inlet, in the fuel injection system and in the lubricating oil system. Air filters should be fitted for all conditions of service and should be easy to clean; a pressure gauge on the downstream side should be included to indicate when cleaning is required. Fuel filters should be of a type which can be changed while the engine is running, and should be capable of filtering out particles down to 1·5 microns in size. Lubricating oil filters are bound up with the type of oil used either "straight" or containing anti-coagulant additives. Paper elements which are thrown away when fouled are now becoming widely accepted in the road vehicle industry. They are perhaps best fitted in conjunction with a coarse strainer of the metal edge type.

Cylinder Heads and Valves.—The design of the cylinder head is now fairly well established with forms having four overhead poppet valves for four-stroke engines; two overhead valves for two-stroke uniflow scavenge engines; and no valves for two-stroke loop-scavenge engines. The injector is usually surrounded by an inserted sleeve, and air and exhaust ports are arranged on opposite sides. Pressed-in or cast-in valve seats of hard material would appear to offer advantages both in cooling and wear, giving consequently longer life: running periods of 3,000 hours are possible without re-grinding becoming necessary. Rotation of the exhaust valve tends to avoid distortion and local hot-spots, and can be achieved by using a valve cap which bears directly on the spring but has a very slight clearance between it and the head of the valve stem.

Lubrication of the valves and valve gear is either by oil under pressure or by grease. The former seems to be coming into more general use as it renders the gear more silent and wear on both stem and guide is reduced. The difficulties are in controlling the supply and draining away the used oil so that it does not enter the cylinder; neither difficulty is present with grease lubrication. No-lash tappets have made little headway in larger engines; a typical mechanical type embodies a spring-loaded eccentric mounted on the end of the rocker lever. This has the serious disadvantage at present that if the valve tends to stick, the eccentric will rotate under its spring load and will prevent the valve from seating. Extended use of a no-lash mechanism may follow better understanding of valve-gear lubrication.

Pistons.—The design of pistons is based on two principal criteria: the shape must be such as to give complete and clean combustion; and the material of the piston and the material and disposition of the piston rings must be such that there is no danger of ring-sticking under any condition of load. As regards the top ring, it must be adequately protected from the flame of combustion, and it is desirable that it should be located to be at the level of the top of the cylinder water space when the piston is at top dead centre. This ensures good heat transfer at this point. The temperature of the top ring should not rise above 200 deg. C. or the rings will become lacquered and finally stick. The temperature is kept below this figure by feeding oil to the underside of the piston crown to cool it. This can be done in a variety of ways, the most effective probably being by passing the oil under pressure up a hole drilled in the connecting rod and through other holes in the gudgeon pin so that it sprays over the underside of the piston.

Piston materials are usually either cast iron or an alluminium alloy. The latter has much to recommend it owing to the smaller loads it imposes on the big end and main bearings. A cast-in ring carrier of high-nickel low-expansion cast iron reduces the rate of wear in the ring grooves. A taper of one or two degrees on the working face of the ring gives adequate oil control.

Liners.—The liner is probably the most vulnerable part of a Diesel engine from the point of view of wear. This can be reduced by (*a*) hardening or chromium-plating the bore and (*b*) maintaining the jacket at a temperature approaching that of boiling water and using rapid circulation. A particular design of liner has a number of longitudinal slots on its outside periphery over which is shrunk a sleeve. The cooling water passes down the outside of this sleeve and up the slots at high speed. With closed circuit operation this gives reduced wear, an almost complete absence of deposits in the jackets and a possible reduction in fuel consumption of between 2½ and 5 per cent.

Crankshaft and Bearings.—Increased speeds and loads have forced the general use of copper-

TYPICAL SCHEDULE OF WEAR TOLERANCES FOR ENGINE OF 8½ IN. BORE.

Description of part	Dimension of part when new	Fitted clearance when new	Maximum allowable clearance, one or both parts to be adjusted or replaced
Main bearing Crankshaft journal	5½ in. + 0·004 in. 0·005 in. dia. 5½ in. ± 0·0005 in. dia.	0·004 in. min. 0·005 in. max.	0·007 in.
Main bearing thrust Crankshaft journal thrust	11⅛ in. − 0·005 in. 0·006 in. between faces 11⅛ in. + 0·002 in. − 0·000 in.	0·005 in. min. 0·008 in. max.	0·020 in.
Large end bearing Crank pin	5⅛ in. + 0·003 in. 0·004 in. dia. 5⅛ in. ± 0·0005 in. dia.	0·003 in. min. 0·004 in. max.	0·008 in.
Connecting rod, small end Small end bush	3⅞ in. ± 0·0005 in. bore 3⅞ in. + 0·0015 in. outer 0·002 in. dia.		
Small end bush Gudgeon pin	3 in. + 0·0035 in. 0·0045 in. bore 3 in. − 0·0005 in. dia. 0·001 in.	0·003 in. min. 0·004 in. max.	0·008 in.
Piston gudgeon pin bosses	3 in. + 0·0005 in. 0·001 in. bore	0·001 in. min. 0·002 in. max.	0·006 in.
Cylinder liner-top	8½ in. ± 0·001 in. bore		0·030 in.
Piston ring (top)—gap Piston rings—gap Scraper rings—gap Piston ring / Scraper ring vertical clearance with ring-bottomed groove	0·026 in. to 0·034 in. 0·020 in. to 0·025 in. 0·020 in. to 0·025 in. 0·004 in. to 0·006 in. 0·001 in. to 0·003 in.		0·060 in. 0·080 in. 0·010 in. 0·010 in.
Camshaft Camshaft bearings	2⅛ in. + 0·000 in. − 0·001 in. dia. 2⅛ in. + 0·002 in. − 0·003 in. bore	0·002 in. min. 0·004 in. max.	0·008 in.
Camshaft thrust clearance		0·003 in. min. 0·004 in. max.	0·012 in.
Air and exhaust cams dimensions base to cam nose: Fuel (naturally-aspirated) Fuel (turbo-charged) Air and exhaust (both naturally aspirated and turbo-charged)	3 11/16 in. 3 13/16 in. 3 15/16 in.		
Valve rocker lever bush Fulcrum shaft for rocker lever	1½ in. + 0·001 in. 0·0015 in. bore 1½ in. ± 0·0005 in.	0·001 in. min. 0·002 in. max.	0·012 in.
Air and exhaust valve stems Air and exhaust valve guides	⅜ in. − 0·006 in. 0·007 in. dia. ⅜ in. ± 0·0005 in. bore	0·0055 in. min. 0·0075 in. max.	0·015 in.
Valves assembled in cylinder head	Valve head flush with face of cylinder head.		
Camshaft drive idler gear bush Camshaft drive idler gear spindle Camshaft and lubricating pump drive gears	2½ in. + 0·003 in. 0·0045 in. bore 2½ in. − 0·000 in. 0·001 in. dia. 0·004 in. to 0·006 in. backlash on P.C. dia.	0·003 in. min. 0·0055 in. max. 0·004 in. min. 0·006 in. max.	0·012 in. 0·020 in.

lead bearings. Wear can be reduced by hardening or chromium plating the crank surfaces and by keeping the lubricating oil clean. The crankshaft is probably most conveniently made as a forging, either solid or split, for large sizes. Alternative designs are made with great stiffness so that all critical speeds are beyond the running range, or relatively flexible with a damper fitted at the free end. Loss of lateral stiffness, however, can give rise to increased cylinder wear.

Camshaft.—The position of the camshaft varies greatly, but in future it must be fitted and forgotten—accessibility need not be the primary concern. In almost all cases at present the fuel pumps are driven from the camshaft and their reactions are transmitted back giving rise to noise at the cams and shock-loading the shaft. A system which eliminates these difficulties has been devised by the British Internal Combustion Engine Research Association and was described in a paper presented to the Institute of Marine Engineers.* In it, fuel from a high-pressure gear pump is fed to an accumulator from which it is admitted to the injectors by servo-operated pistons, the timing being controlled from a light camshaft.

10,000 HOURS BEFORE OVERHAUL

The form which a turbo-charged Diesel engine of the future would take so that both initial and running costs should be a minimum can now be summarised. By using adequately filtered non-detergent lubricating oil with the dry-sump system, the bearings and insides of the piston will be permanently clean. This cleanliness, coupled with the hardened crankshaft and pre-fitted bearings will result in " no-wear " conditions in these components for up to 10,000 hours. The crankshaft and its associated big-ends, therefore, can be shut away and forgotten. With closed-circuit cooling and a heat exchanger the cylinder jackets themselves can be forgotten, and the life of the liner will be greatly increased. The fuel-injection system will be of the servo-operated type; it will be accessible but being divorced from the main camshaft the latter may be placed in a convenient though possibly inaccessible position. The engine will probably be of the V-formation, and so designed that the cylinder and liner can be removed without disturbing the big-end; the separate cylinder form will probably be used. For such an engine the maintenance calendar would be: 250 hours, clean the fuel and lubricating-oil filters; 3,000 hours, clean piston and examine valves; and 10,000 hours, major overhaul.

* W. P. Mansfield, " Some Fuel Injection Problems," *Proc.I.Mar.E.*, page 309, December, 1954.

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EX-SERVICE EQUIPMENT FOR WEATHER FORECASTING

The beating of swords into ploughshares in the electronic field is being done by Winston Electronics, Limited, Shepperton, Middlesex. They are renovating and modernising the equipment known to the services as the Radar, A.A., No. 3, Mark II, so that it can be used for mobile radar meteorological work. The equipment is mounted in a trailer, and part of the alteration consists in providing an air-conditioning refrigeration unit so that the trailer can be used with reasonable comfort even in tropical countries. All the equipment in the renovated trailers is suitable for tropical usage, all the original wiring has been replaced by p.v.c. insulated wire, and no rubber is used for insulation.

The main purpose of the equipment is to determine upper wind velocities, which it can do by supplying continuous and accurate information on the range, bearing and elevation of targets. Accuracy is claimed to be within 10 yards for range and 3 minutes of arc for bearing and elevation. Four operators are required, one for technical adjustment and one each for range, bearing and elevation.

THE PROFESSIONAL ENGINEER AND HIS EMPLOYER

UNION TYPE BODIES IN BRITAIN AND U.S.A.

From a Correspondent

The accelerating growth in the number of graduate engineers and corporate members of the engineering institutions has been accompanied by a substantial rise in the numbers employed in industry. There are to-day about 90,000 corporate members of the three senior institutions, in addition to a growing number in the younger bodies such as the Chemical and Production Engineers, although to some extent membership overlaps. Unfortunately, there is no precise knowledge of the pattern of employment of this important body of people. A good guess at the number employed directly in the Civil Service is 8,000; between 4,000 and 5,000 are employed by the Central Electricity Authority and the Local Electricity Boards; a further thousand or so will be employed in the other nationalised industries, with a growing number by the Atomic Energy Authority; and a large number are on the staffs of municipalities. When allowance is made for those engaged in private consulting practice, it would appear that at least three-quarters of our professionally qualified engineers are in private industry and the number is growing fast. This compares with about 90 per cent. in the United States.

Few professional enginers are members of an association for the protection of their economic interests and the advancement of their status, whereas all doctors and lawyers belong to bodies which combine these functions with those of upholding the ethical and educational standards of their members. In the main, only those in public service are represented by trade-union type bodies, the chief ones being the Institution of Professional Civil Servants, the Electrical Power Engineers' Association, the Gas Officers Guild, the National Association of Local Government Officers and the Association of Local Government Engineers and Surveyors. In private industry, the Association of Scientific Workers has a number of engineer members, mostly in the electrical industry, and has negotiated a procedure agreement with the Engineering Employers' Federation. It is unlikely, however, that a total of more than 15,000 professional engineers are represented by bodies of this sort.

WAGNER ACT

In the United States the passing of the National Labour Relations Act (Wagner Act) in 1935 legalised the practice of plant-wise elections to determine the union which should have the right to negotiate for all the employees in a plant. According to an interesting report just received* this led to numbers of professional engineers finding themselves subject to negotiations by particular unions against their will. Because of this, several professional bodies proposed amendments to the Wagner Act by which recognised groups of professional employees could be exempted from inclusion in any bargaining unit recognised by the National Labour Relations Board and these amendments were incorporated in the Taft-Hartley Act in 1947. This still left the question of what, if any, type of organisation should defend the status and conditions of employment of such people. A number of so-called professional trade unions have been formed, the majority of them affiliated to the " Engineers and Scientists of America," but there is considerable argument about the size of their membership, with 10 per cent. of those eligible the likely maximum.

One of the obvious difficulties facing such bodies is the definition of " professional " engineer. Some states in America have registration laws for engineers (although this does not prevent a qualified engineer working in industry without registration), but this is not a sufficiently wide-spread practice to be used and the definition finally included in the Taft-Hartley Act is a long-winded statement of the nature of professional work of all kinds, and of the training required, which resembles that adopted by the Commonwealth Conference of Engineering Institutions in 1954. These definitions are merely expansions of the dictionary definitions by which a profession is described as an employment or vocation using some branch of learning. It will be noted that there is here no question of status or code of conduct and it would seem that these concepts have been pre-empted in modern times by professions such as law and medicine, whose members' activities affect the physical and moral integrity of the individuals who are their clients. On the other hand, codes of conduct have been the concern of vocational guilds for centuries. So far only the consultants among engineers have felt the need to establish similar codes of conduct in this country, although in the United States the non-existence of such a code has been of advantage to American industry and does not appear to have had harmful results.

ENGINEERS' GUILD

The National Society of Professional Engineers in America is opposed to unionisation on the ground that it is inimical to professional ethics and professional unity. In this country a similar view is taken by the Engineers' Guild, which was established in 1938 to unite the profession and raise its status by collective action and which to-day has a membership of between 4,000 and 5,000. Neither body, however, is at all clear as to what it really wants and how it should operate. They are both interested in salary scales, but appear to believe that these can be achieved mainly by adequate propaganda. This attitude might be compared with the very definite pressure for the economic interests of their members exerted by the British Medical Association and the National Farmers' Union. On the other hand the Guild can assist its members in the making of service agreements and in cases of wrongful dismissal, breaches of contract and so forth.

It is when they come to what the Guild describes as the " intangible attributes " of a profession that these bodies have to fall back on expressions which in no way distinguish membership of a profession from good citizenship. Even the attitude to be adopted towards an employer is little different from that which operates in any good employment relationship, with due account for what is appropriate to the level of education, responsibility and remuneration. And that is the gist of the matter. Most professional engineers to-day are employees, the majority in private industry, and it is difficult to see how, except in degree, their position differs from that of other employees, whether in the administrative ranks or, for that matter, among the manual and clerical staff. It would certainly be difficult to define in what way a man, who is a corporate member of an engineering institution, should behave differently from one in a position of similar responsibility who is not. Even attempts to define a code of conduct for managers, whose actions certainly affect the lives of other individuals, have run into difficulties. Engineers have a right to be proud of their vocation, but they must not confuse their claim for recognised status and remuneration with one for recognition that they are not as other men.

* *A Professional Look at the Engineer in Industry*, National Association of Professional Engineers, Washington, D.C., U.S.A.

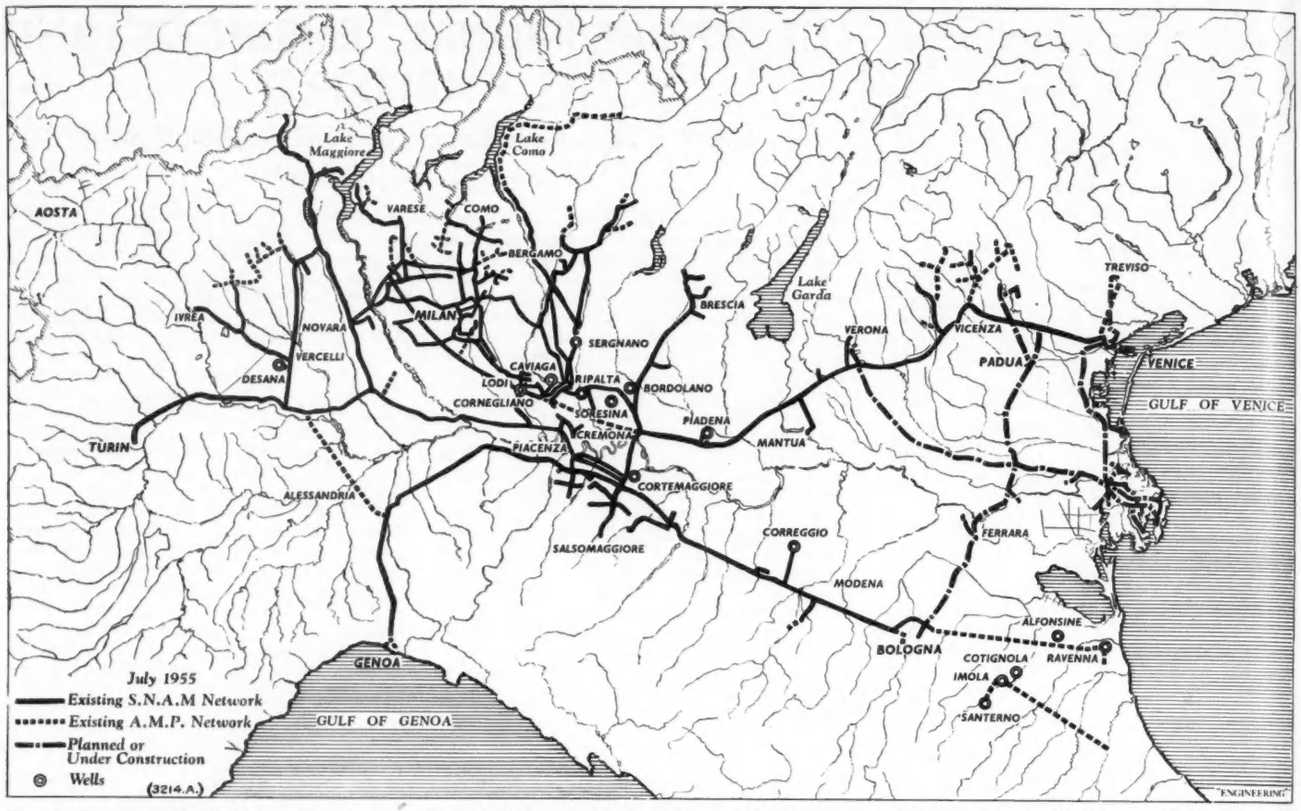

Fig. 1 The main distribution system for natural gas in Italy consisted, in July, 1955, of more than 2,400 miles of pipe-line owned by two main companies. The wells are concentrated round Piacenza and the seaward end of the Po Valley.

NATURAL GAS

EXPLOITATION IN ITALY, EXPLORATION IN ENGLAND

There are deposits of natural gas in many parts of the world, and the existence of some of them has been known for many years. Until the second half of the Nineteenth Century, however, there was no systematic exploitation of any of the known deposits; the first two recorded uses were just before 1870, one in the United States of America and the other in Northern Italy. Development in the United States was continuous after 1870, and the industry there is now very large. In Italy, however, the main gas fields were deeper in the earth's surface, and it was not until a comprehensive survey had been made that commercially-usable quantities of gas were found. The main fields have been discovered since the second World War, and the last few years have seen a remarkable expansion of the Italian natural gas industry.

In England the Gas Council are sponsoring a programme of drilling for natural gas, which is described later in this article. Should gas be found in substantial quantities in England we shall be able to benefit greatly from the experience of the Italians and the Americans in overcoming problems of drilling, distribution, and utilisation. Although the industry in America is technically very advanced, the development of the Italian natural gas system is probably of more interest to us; development has been rapid and of recent date, and the difficulties they have had to overcome are those which would confront us if a sudden expansion in the use of natural gas becomes economically possible in England.

Natural gas is methane occurring naturally with or without other hydrocarbons and small quantities of other gases. In general, the methane is mixed with other gases; in the United States, for example, the proportion of methane may vary from 60 to 95 per cent. according to the field. Examples of other gases present are butane, propane, carbon dioxide, nitrogen, helium, and, occasionally, sulphuretted hydrogen. Since it does not contain carbon monoxide natural gas is not poisonous, but it can form explosive mixtures with air. For this reason an odorant is added when the gas is used commercially so that leakages can be detected; substances used as odorants have been ethyl mercaptan and a cyclic sulphide called Calodorant C. The speed of flame propagation in natural gas is about a quarter and its calorific value about twice that of coal gas; appliances designed for coal gas must therefore be altered before they can use undiluted or unaltered natural gas.

ITALIAN DRILLINGS AND DISCOVERIES

Salsomaggiore is near Piacenza, which is shown in Fig. 1, and the first industrial use of natural gas in Italy was made there in 1869, when methane was used for the recovery of salt by the evaporation of brackish waters. By 1890 there was a complete distribution network in the town which has survived until the present time. Other exploitation of natural gas sources in Italy was sporadic and almost entirely by private individuals or companies, until the Italian Government decided in 1926 to make a more systematic investigation. They set up the Azienda Generale Italiana Petroli (A.G.I.P.) with the aim of investigating and drilling the national subsoil for liquid and gaseous hydrocarbons.

In 1938 the researches of A.G.I.P. were successful at Fontevivo near Parma and Podenzano near Piacenza when gas fields were found at depths of between 2,500 and 3,300 ft. The Podenzano wells were connected to Milan by a pipe line 43 miles long and about 3½ in. in diameter; these wells were exhausted after more than 7,000 million cub. ft. had been taken from them. In 1941 A.G.I.P., drilling to a depth of about 4,000 ft. discovered a much more extensive field at Caviaga, near Lodi. It is from the discoveries of these and subsequent deep drillings that the important sources of the present day industry come. Drilling was discontinued during the war, but in 1945 a more comprehensive drilling programme was started. A second drilling was made at Caviaga, and fields were located at Cortemaggiore, Ripalta, Cornegliano, Bordolano, Correggio and Ravenna, all of which are shown in Fig. 1.

As can be seen from the map the main sources of natural gas near Piacenza are some distance from the industrial centres of Milan and Turin. When it was realised that the reserves of natural gas were large enough to make its widespread use an attractive economic proposition, it became necessary to plan and build a distribution system. This system has grown very rapidly, and its development up to July 1955 is shown in Fig. 1, together with extensions either being constructed or being planned.

The Ente Nazionale Idrocarburi (E.N.I.) has recently been established to co-ordinate all Government enterprises in the field of liquid and gaseous hydrocarbons. The A.G.I.P. is responsible for the development and investigation of suitable wells, and the gas is distributed by two main companies, S.N.A.M. and A.M.P. The Società Nazionale Metanodotti (S.N.A.M.) manage the principal gas pipe-line network; the present main network consists of about 1,750 miles of pipe-line and 1,250 miles are being planned or constructed. The Azienda Metanodotti Padani (A.M.P.) operate the network at the seaward end of the Po Valley, consisting of about 400 miles of pipe-line. There is also a small company operating a network which connects the Po delta wells with the Appenine Tuscan-Emilian fields and Florence.

LEGAL AND TECHNICAL DIFFICULTIES

Difficulties in constructing the pipe-lines have come under two main headings, legal and technical. There is as yet no adequate legislation governing the construction and working of methane pipe-lines. The absence of such legis-

lation makes obtaining wayleaves a difficult matter; the difficulties are much accentuated in Italy where there is a complex system of public bodies with rights over the ground, an extreme division of the land under private ownership, high density of population, and a close network of road and rail communications. It is not possible to make laws protecting the interests of all concerned without considerable delay, but in spite of the difficulties and the very large number of wayleaves which have already had to be obtained, the network continues to expand.

Technical difficulties result partly from the requirements of a satisfactory high pressure pipe-line network, and partly from an initial lack of suitably experienced labour. Some of the requirements for a pipe-line system are: the routes should be planned to avoid built-up areas and subsidence areas; when the pipes are run above or on the ground provision should be made for expansion, and for this reason pipes should not use road or railway bridges when crossing canals or rivers, but should traverse the obstacle either underground by a thrust boring or overground by a special pipe-line bridge of the type shown in Fig. 2. (The bridge shown carries a 13 in. pipe-line connecting the wells at Caviaga and Cornegliano); when pipes are laid underground they must be protected against electrolytic action.

The capacity of the present day network is about 780 million cub. ft. a day, and the diameter of the largest pipe-line is 16½ in., an example of which is the 130 mile line between Cortemaggiore and Turin. The main lines are Mannesmann tubes made of welded carbon steel, running at a pressure of between 570 and 850 lb. per sq. in. On the distribution branch pipe-lines the pressure is reduced to 170 to 210 lb. per sq. in., and for industrial use the pressure is further reduced to 7 to 21 lb. per sq. in.

METHANE AS FUEL

Methane is used either as a fuel or as the raw material for chemical syntheses. As a fuel it is used in power stations, in factories, in homes, and to a limited extent as a fuel for vehicles; in chemical plants it is used for hydrocarbon synthesis, acetylene, and other derivatives; in 1954 the consumption of methane as a chemical raw material and as a fuel in chemical plants amounted to about 12 per cent. of the total production.

The use of methane as a fuel presents certain problems, arising from its basically different properties from coal gas. Where it is used in specially designed apparatus, which is always the case in large plants, there are no serious problems. The difficulty arises when methane is used for duties which have previously been performed by coal gas. Either the methane must be changed so that it can be burnt in the coal-gas appliances, or the appliances must be modified to burn methane. In any proposed alteration it has to be remembered that the supplies of methane may not last for long, or may be interrupted; in either case alternative stand-by gas should be available.

In Italy methane has been used as a fuel in the following ways*: methane enrichment of manufactured gas, re-forming of methane, use of air-methane mixtures, supply of undiluted natural gas through existing distribution systems, and supply through newly built gas distribution systems.

Enrichment of Town Gas.—The calorific value of the manufactured gas distributed in the larger Italian towns is 367 B.Th.U. per cubic foot, and that of methane is about 1,000 B.Th.U. per cubic foot. (The average calorific value of natural gas, which contains gases other than methane, is about 955 B.Th.U. per cub. ft. For many practical purposes, however, natural gas can be regarded as methane.) The simplest method of using methane is to add it to town gas, thus enriching the latter to a calorific value of about 397 B.Th.U. per cubic foot. It is unecessary to modify the appliances for this change in calorific value.

Re-forming of Methane.—Re-forming processes are based on the principle that hydrocarbon gases suitably heated in the presence of air or steam, or both, break down into simpler hydrocarbons, hydrogen and carbon monoxide. A high reacting temperature is necessary to effect reasonably efficient re-forming. The process is endothermic in steam and exothermic in air, and there are thermal losses by radiation and on account of the heat content of the products. On a commercial scale, however, the process lends itself to the recovery and utilisation of sensible heat. Re-forming is greatly facilitated by the presence of a catalyst.

In Italy re-forming is carried out either with steam, as at Milan, Verona, and Venice gas works, to give a calorific value of about 320 B.Th.U. per cubic foot, or with air, to give a calorific value of about 200 B.Th.U. per cubic foot. Since the re-formed gas has a high hydrogen content but a low calorific value methane has always to be added. For interchangeability and economy it is advisable to add flue gas or air as well as methane, in order not to have a gas too rich in hydrogen. By using methane re-formed in this way it is always possible to obtain a gas interchangeable with that previously distributed, although the calorific value may be slightly different in some cases. This method therefore offers the great advantage that substitution is possible without altering the consumers' appliances. The main disadvantage is that a considerable amount of heat is wasted in the re-forming process, and the overall efficiency can vary between 60 and 90 per cent.

Air-Methane Mixtures.—Under certain conditions it has been found economic to use a mixture of air and methane, the mixture having a calorific value of about 495 B.Th.U. per cubic foot. This mixture can almost take the place of coal gas at 397 B.Th.U. per cubic foot, except that it cannot be used in non-aerated burners of water-heaters and pilots. In order to give a mixture of constant quality certain precautions must be taken, and special mixing plant must be used. In order to keep the mixture in constant proportions the pressure must be controlled in accordance with variations in flow, and variable flow rates call for the use of several injectors. In some cases the pressure of the methane is insufficient for the satisfactory use of injectors, and the air must be compressed; this brings in its train the need for more elaborate safety devices. The number of gasworks using air-methane is small, but there are a number of works which have used a mixture of air-methane and coal gas.

NATURAL GAS USING EXISTING DISTRIBUTION SYSTEM

Where there is a constant and assured supply of natural gas the most satisfactory but most radical solution is to use natural gas through the existing system instead of coal gas. There are a number of technical difficulties in doing this, which will be enumerated, but the experience of towns that have adopted this method has been very encouraging.

The increase in calorific value from 367 to 955 B.Th.U. per cubic foot causes a reduction in the volume of gas sold until consumers take advantage of the more economic charges. There is a large increase in "unaccounted for" gas; considered as a percentage of the total heat sold this may rise from 10 or 12 per cent. for coal gas to 30 or 35 per cent. for natural gas. This great increase in loss is partly because methane has a viscosity lower than that of town gas, and an almost similar specific gravity, so that leakages are increased.

Many of the meters become inaccurate when the volume of gas passing through them is 60 per cent. lower than formerly; it is therefore necessary to test all meters immediately after a change-over, and to replace a large percentage of the total number.

Adjustment of consumers' appliances presents one of the major tasks in a conversion; all injector nozzles must be replaced; the burner port area must be increased in most cases; all gas jets of water heaters, burner rows, and all devices where gas is burnt without aeration must be replaced. In order to effect orderly and rapid replacement it is usual to sectionalise the distribution network—itself an additional task—and to change over section by section.

Because the gas is of higher calorific value and its production costs are small there is a general assumption that the price of the gas to the consumer should be considerably lower than that of coal gas. But costs of a gas undertaking are largely overheads, and the most satisfactory way of reducing the price to the consumer per unit of gas is to encourage him to use more. This is achieved by block tariffs, where the first block is rather more expensive than subsequent blocks, which gradually decrease in cost.

REMARKABLE CONSUMPTION INCREASE IN CONVERTED SYSTEM

The Lodi gasworks was the first in Italy to convert completely to undiluted natural gas. Before November, 1950, the town was served with a mixture of coal gas and producer gas having a calorific value of 367 B.Th.U. per cubic foot. There were about 5,000 consumers and three gas holders, two of 70,000 cubic ft. each and one of 21,000 cubic ft. The conversion

Fig. 2 A special pipe bridge for the crossing of the Adda carrying a 13 in. diameter pipe connecting the wells at Caviaga and Cornegliano.

* This information is largely derived from a paper given by Dott. Ing. A. Böhm at the annual general meeting of the Institution of Gas Engineers, May 31 to June 3, 1954.

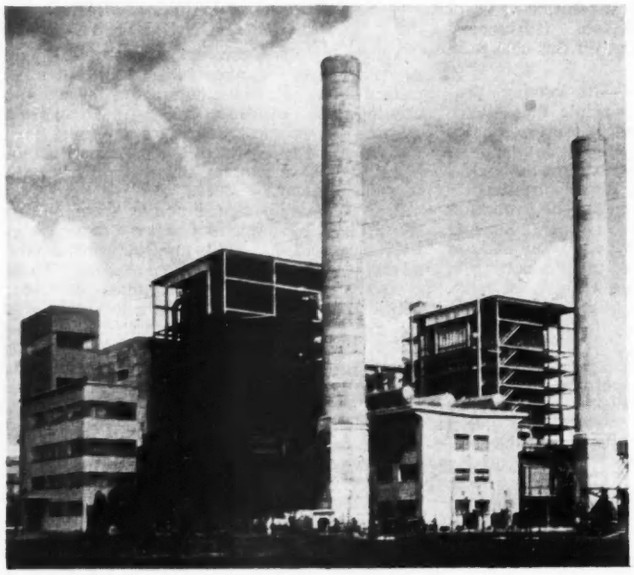

Fig. 3 Tavazzano power station can be run on either natural gas or fuel oil; natural gas is normally used, and fuel oil is kept as a standby. The boilers for each of the two 62·5 MW units are of the open-air type.

was made by dividing the town into 29 sections and was done in about 55 days. The total cost, including sectionalising and appliance conversion, was about £5,000.

The increases in overall consumption, number of consumers, and consumption per head are shown in Fig. 4 and Table I.

TABLE I.—*Number of Consumers and Average Annual Consumption.*

Year ended December 31	1949	1950	1951	1952	1953
Number of consumers ..	4,887	4,994	5,856	6,653	7,224

Average annual consumption per consumer of methane or methane equivalent. (Year April 1 to March 31.)

Year	1949–50	1950–51	1951–52	1952–53	1953–54
Cub. ft. per year	4,167	4,485	20,977	35,562	37,716
Therms per year	42·6	45·9	214·5	363·6	385·7

After conversion the price of gas in Lodi was governed by block tariffs; from 1949 to 1953 the average price declined from about 17*d.* per therm to about 11*d.* per therm. The increase in consumption has needed additional feeders and low-pressure pipe lines, but the much greater winter space-heating load has produced a flatter hourly send-out curve, thus allowing greatly increased consumption with only a moderate expansion of network capacity. The proportion of unaccounted-for gas was reduced to 13 per cent. in 1953–54. Other Italian towns that have since converted to the use of undiluted natural gas are Fiorenzuola, Cremona, and Brescia.

Natural Gas Through Newly-built Distribution Systems.—Some small centres, previously without a supply of gas, have been able to design a system specially for natural gas. In these cases there is no problem of appliance conversion, and the only problem is that of suitable standby capacity. In the case of Monselice, typical of such centres, there is a plant designed to distribute automatically a standby reserve of gas (14,200 cub. ft.), contained in a holder at 285 lb. per sq. in., should the natural gas supply fail. This arrangement proved excellent when the operation of the natural gas pipe line was interrupted in 1951, due to flooding in the Po Valley. There are also possibilities in the provision of a reserve of liquified petroleum gas-air, which may be interchangeable with natural gas within certain limits.

INDUSTRIAL USES: TAVAZZANO POWER STATION

The use of natural gas in industry to replace other fuels has become widespread. Some engineering and steelworks which are adapted to use natural gas are Fiat, the plant of Franco Tosi at Legnano, the Falk and Breda steelworks at Milan, and the Dalmine steelworks, Italy's largest tube manufacturing firm. In cement manufacture natural gas is used in rotary kilns; in glass manufacture the tank furnaces of S.A. Vetrocoke at Marghera, with a capacity of 1,200 tons, and a glass yield of 80 to 85 tons a day, are using natural gas. It is also used in glass production at Murano, ceramic furnaces, brick furnaces, and limekilns. Investigations are being made into the substitution of natural gas for coke in the reduction of iron ores, and the use of natural gas in internal-combustion engines and turbines.

Natural gas is used as the power source at two electricity generating stations, Piacenza and Tavazzano. The Tavazzano station has a number of interesting features. Tavazzano, about 4 miles north east of Lodi, was chosen as the site for the first natural gas power station for several reasons: it is near the main gas fields, and is connected to both Cornegliano and Caviga by pipe-line; on present estimates the reserves at Cornegliano will last for at least 15 years; it is near several main electricity transmission lines, and it is on the banks of the Muzza canal, which can provide adequate cooling water all the year round.

The station is constructed on the unit principle, each of the two units consisting of a boiler fired by natural gas or fuel oil, a steam turbo-alternator, and transformer, and auxiliary services. The maximum output of each unit is 62·5 MW. A reheating cycle is used; superheated steam at 1,775 lb. per sq. in. and 520 deg. C. is admitted to the high-pressure stage of the turbine, and is exhausted at 425 lb. per sq. in. Before passing to the intermediate and low-pressure stages the steam is reheated to 510 deg. C. The maximum temperature is restricted to 520 deg. C. to avoid the expense of using special austenitic materials. The boilers are built in the open air, as is shown in Fig. 3, and the alternators are hydrogen cooled.

The boilers can be fired by natural gas or fuel oil, the latter being used only when the supply of natural gas is interrupted. The gas is transferred from the wells through cleaning and filtering apparatus to a measuring chamber. After being measured the gas is fed to the two boiler units; before each boiler there is a pressure regulating device which is of particular interest. The supply to each boiler can pass through one of two parallel paths; one leads through a reducing valve, and the other through a natural-gas pressure turbine. The drop in pressure is regulated so that pressure on reaching the boiler remains constant; the turbine drives an auxiliary alternator, and at full output the two auxiliary alternators produce 1·2 per cent. of the total power. The gas delivered by the main pipe-line is at 550 to 700 lb. per sq. in. pressure, and the pressure at the turbine exhaust is 17 lb. per sq. in.

Fuel oil is held as a reserve in a tank with a capacity of 105,000 cub. ft., and can be pumped to special jets in the boilers.

RAW MATERIAL FOR CHEMICAL INDUSTRY

The re-forming of methane, as explained above, results in the production of simpler hydrocarbons, hydrogen and carbon monoxide. Methane has been used in the manufacture of hydrogen for some time, but since the war it has become more important as the raw material for making acetylene and other substances. By incomplete combustion with oxygen it can be converted into carbon monoxide, carbon dioxide, hydrogen and water. The heat developed by this process is sufficient to increase the temperature of the mixture to about 1,400 deg. C., and to furnish heat for the transformation of the remaining methane into acetylene and hydrogen. From the resulting gas mixture it is possible to recover acetylene sufficiently pure for chemical syntheses.

Another substance which can be produced from methane is ammonia. Plants for making ammonia from methane are those of the Società Montecatini at Novara and Ferrara, of the S.A. Vetrocoke at Marghera, and of the Società Edison also at Marghera. Hydrocyanic acid can be obtained by a reaction of methane with ammonia, and with these substances as raw materials plants can be designed to make many other synthetic chemicals.

DRILLING IN ENGLAND AND SCOTLAND

In Great Britain a programme of exploration for natural gas deposits has been started under the auspices of the Gas Council who are devoting about £1 million to this purpose. Exploration

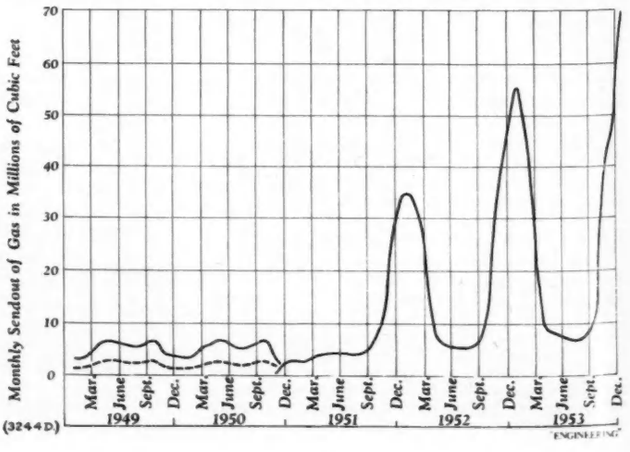

Fig. 4 Gas sent out from Lodi gasworks, 1949 to 1953. The unbroken line shows the actual consumption of coal gas or natural gas, the broken line the equivalent methane consumption before the change over in November, 1950.

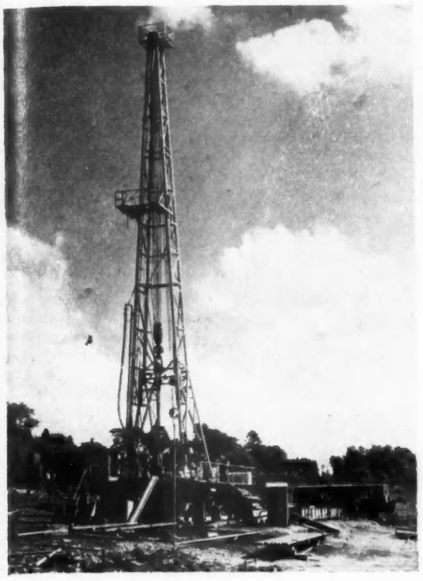

Fig. 5. Exploratory drilling for natural gas at Crowborough, Sussex. The jack-knife derrick is 87 ft. high; in the background are mobile geological and petroleum engineering laboratories.

is being done by the D'Arcy Exploration Company, a subsidiary of the British Petroleum Company, Limited, Britannic House, London, E.C.2. The aim of the present programme is to discover where the natural gas deposits are and which of them can be developed economically.

The areas chosen for initial exploration were Cousland, Midlothian, the East Riding of Yorkshire, Lincolnshire, and the Ashdown Forest area of Sussex. The presence of gas at Cousland was known before the Second World War, and no further detailed survey was necessary. Drilling of a trial well, to supplement the information already available from existing wells at Cousland, was started on February 15, 1954, and was carried to a depth of 1,918 ft., at which the well was plugged on May 7, 1954. Although the presence of gas was confirmed, the quantities indicated were less than had been hoped for from previous work in the area, and it was decided to defer consideration of further work on the site in order that progress might be made with exploration in other parts of the country.

Extensive areas in Lincolnshire and in the North and East Ridings of Yorkshire have now been surveyed with the object of finding favourable geological structures at depths which might hold accumulations of gas comparable with those found in the gas fields of Holland and north-east Germany. The results are being examined in order that sites may be chosen for trial wells, by which alone the presence of gas in a potentially promising structure can be determined. Particular interest is being taken in the areas of Yorkshire beneath which the Permian limestone extends.

As at Cousland, much was already known of the geological structure of the Ashdown Forest area, and a suitable site was obtained at Crowborough, Sussex, where drilling began in June, 1954. Gas was found at depths of 813, 941, 1,097 and 2,900 ft., and the well was eventually taken to 4,583 ft. Although the amounts of gas found were not large they were enough to justify the drilling of a second trial well. The site of the second well is about one mile from the first site, and drilling has been continuous there for most of the summer.

A general view of the second well is given in Fig. 5. The 87 ft. jack-knife derrick is the principal feature, but a number of other important items can be seen in the illustration. When drilling, fluid is pumped down the inside of the drill, and on reaching the bottom passes through ducts in the drilling bit and brings up to the surface the soil and rock which have been drilled away. The fluid, a mixture of water with varying amounts of fullers' earth and certain chemicals, serves also to plug any fissures which may occur in the sides of the drilling. When the fluid containing the drillings reaches the surface it passes over a shaker. This separates the drillings from the fluid, and they are analysed by the site geologist, who thus can keep an accurate and up to the minute chart of the geological strata. The fluid then passes through the mud tanks where it can be diluted or thickened as required before passing back down the drill.

The pumps to pump the fluid round are 7¼ in. by 12 in. Ideal mud pumps, driven by 150 h.p. A.E.C. Diesel engines; there are two pumps, each with its own engine, and one acts as a standby. The power to drive the drill and winch is supplied by three 150 h.p. A.E.C. Diesel engines which are on the platform just behind the derrick. They are coupled together as required by torque converter.

In the background on the right is the mobile petroleum-engineering laboratory, where samples brought up from the well are analysed for oil and gas content. On the left and behind the derrick is the mobile geological laboratory, where samples from the well are continuously analysed and a log is kept of the well and the geological structure through which it passes. Electricity is generated by mobile plant, and the only supply which must be obtained locally is a sufficient quantity of water; otherwise the site is completely self-contained.

From the above account it can be seen that the Gas Council are making determined efforts to find natural gas in commercial quantities in Great Britain. They state in their sixth annual report: "Natural gas at present accounts for 23 per cent. of the available gas production in Europe. It may be too much to hope that natural gas will supply so large a proportion of the gas requirements in Great Britain; but having regard to the price now paid for coal, even a modest success would be a handsome reward for the Council's expenditure." The Council also requested the Institution of Gas Engineers to prepare a report on natural gas and methane, which was presented to the Council in April, 1955. If natural gas is found in sufficient quantity, information has already been gathered, mainly from the United States and Italy, so that it will be put to the most economic use as soon as possible.

MEASURING SMALL DIAMETERS WITH PRECISION*

FINE WIRES TO WITHIN 0·000 01 INCH

By I. G. Morgan, B.A. (Oxon)

In modern radio valves and other electronic apparatus, very fine wires, usually of tungsten, are commonly employed as filaments, and for the efficient operation of such apparatus it is necessary for the diameter of the wire to be known to a high degree of accuracy, to be uniform throughout its length and that the cross section should be truly circular. For determining these properties and ensuring that they are maintained in production, a new method for the precise measurement of the diameter of fine wire has been developed in the Metrology Division of the National Physical Laboratory, Teddington, and is described and the method of employing it is explained in this communication issued by the Laboratory.

The apparatus, illustrated diagrammatically in Fig. 1, enables wire up to about 0·01 in. in diameter to be measured to an accuracy of ±0·000 01 in. or better. A principal feature of the design is the use of a very light contact load at the measuring anvils so that when the wire is of very small diameter, or of a soft material, errors of measurement due to compression of the wire are reduced to a minimum.

The wire to be measured lies with its axis horizontal between two anvils, one fixed and the other movable, as shown in Fig. 1. The fixed anvil is attached to the base plate of the apparatus and the movable anvil is carried by a balanced beam which can tilt about a horizontal axis. Attached to the beam is a small plane mirror which may be viewed by an appropriately placed autocollimator. The angle of tilt of the beam, and therefore of the mirror, varies with the diameter of the wire between the anvils. Variations in this angle are measured by means of the autocollimator shown on the right of the diagram and the distance from the centre of the movable anvil to the axis of tilt of the beam is such that a change in diameter of 0·000 005 in. gives rise to a change in angle of one second of arc. The autocollimator readily detects a change of this magnitude.

The construction of the apparatus is shown in Fig. 2. The upper surface of the hardened-steel base plate is lapped so that slip gauges, which form the lower fixed anvil, may conveniently be wrung to it. Attached to the base is a steel U-piece in which are mounted the selected precision ball bearings which form the pivot for the tilting beam. The ball bearings are mounted in such a manner that they are slightly loaded axially so as to take up any play which may be present in the races. The tilting beam carries the movable anvil at one end, the actual contact face being a lapped flat of circular outline 0·05 in. in diameter. The other end of the beam consists of two rods threaded over a portion of their lengths. On to each of these rods is screwed a cylindrical weight and by moving the weights

* Communication, entitled "The Precise Measurement of the Diameter of Fine Wire," from the National Physical Laboratory, Teddington.

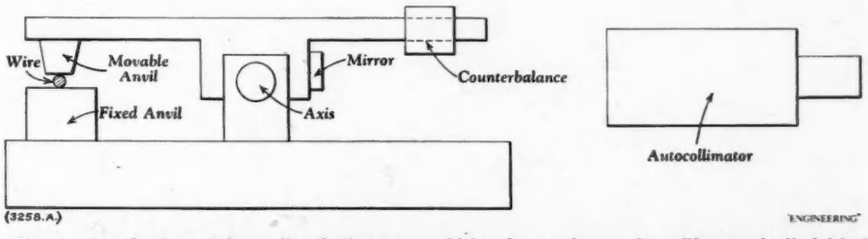

Fig. 1 The fixed anvil is a pile of slip gauges which, after setting-up the collimator, is diminished by the nominal diameter of the wire. The difference between the actual and nominal diameters is measured as a deflection of a beam of light.

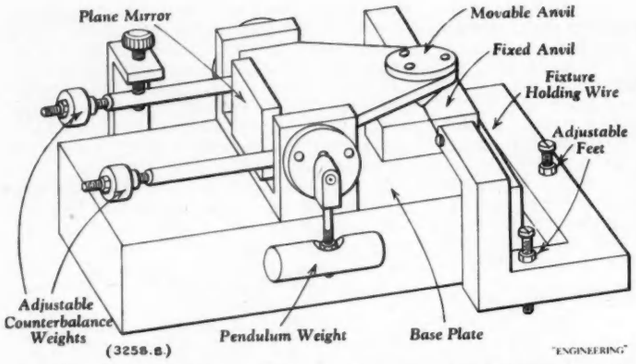

Fig. 2 Apparatus arranged for use. The effective anvil weight is determined by the differential adjustment of the counterbalance weights and the pendulum weights. The correct location of the wire on the fixed anvil is obtained by adjusting the feet on the holding fixture.

along the rods the balance of the beam, and thus the contact load at the anvils, may be closely adjusted, the weights being then fixed in any desired position by means of locknuts. The mirror is fixed to the beam in a position between the threaded rods as shown. Mounted on the base, as shown on the left in Fig. 2, is a bracket carrying a knurled screw which, when screwed inwards, bears down on one of the rods. The anvil may thus be raised or lowered by turning the screw in the appropriate direction.

The ends of the spindle carrying the beam in the ball bearings pass completely through the inner races and protrude outside the U-piece. Rigidly attached to these ends are arms which hang downwards and carry "pendulum" weights. These weights may be moved up and down the arms so that the position of the centre of gravity of the tilting beam, of which the pendulums form an integral part, may be adjusted in the vertical plane. Such adjustment facilitates the setting of a very light contact load at the anvils.

ABSOLUTE OR COMPARATIVE MEASUREMENTS

The manner in which the instrument is used depends on the type of measurement required. Two applications will be described, first the determination of the absolute diameter of a wire and secondly the investigation of variation in diameter along the length of a wire. For the determination of absolute size the lower anvil consists of a pile of slip gauges wrung to the base plate under the movable anvil. The reading of the autocollimator is first taken when the movable anvil rests directly on the upper surface of a slip-gauge pile of height, say, h_1 in. This slip-gauge pile is then replaced by another of height h_2 in. with the wire, the nominal diameter of which is, say, d in., resting on it. The height h_2 in. of the second slip-gauge pile is chosen so that $h_1 = h_2 + d$. With the movable anvil now resting on the wire a second reading of the autocollimator is taken, this reading, of course, showing the difference between the actual diameter of the wire and the nominal diameter for which the pile of slip gauges has been set. The difference between the two readings thus enables the actual diameter of the wire to be calculated.

Clearly, if an accurate result is to be obtained it must be ensured that when the moving anvil is in the measuring position with the first slip-gauge pile the surfaces of anvil and slip-gauge pile are accurately parallel. This is done by lapping the contact face of the anvil *in situ* using a parallel-faced lap located off the base plate. The height h_1 in. of the slip gauge pile is then made equal to the thickness of the lap, which is nominally 0·5 in. It must also be ensured that the wire to be measured is in proper contact with both anvils. For this purpose the wire is mounted in a suitable fixture, an example of which is seen on the right in Fig. 2. The position of the fixture is set by means of three adjustable feet so that the wire, lightly tensioned, lies flat across the surface of the fixed anvil and just in contact with it. This setting must be carried out with care, par icularly when a very light contact load is being used. It is not, in general, necessary that the wire should lie precisely under the centre of the moving anvil, so that positioning may conveniently be done by eye, but if it is desired to place the wire in a central position this may readily be done by locating the fixture holding the wire against appropriately placed stops. A displacement of the wire from the central position does of course give rise to a slight change in sensitivity but since h_2 is always adjusted so that the measured quantity (given by the difference between the two readings of the autocollimator) is small, any error so introduced is negligible.

Fig. 3 illustrates an arrangement whereby a specimen of wire may be examined for variation in diameter along its length. The instrument is set up on a surface plate with the wire mounted in a fixture, shown on the left, which may be traversed along a straight-edge. A pointer attached to the fixture registers against a scale on the straight-edge and a series of readings at known positions along the wire may thus be obtained. For this purpose, since variation in diameter only is being measured, a fixed anvil of the form shown in Fig. 4 can be used with advantage. The wire is lightly tensioned in the fixture and its position in relation to the fixed anvil is adjusted so that it is always in contact with this anvil as it is traversed. In the particular mounting fixture shown in Fig. 3 the clamps holding the ends of the wire may be rotated about an axis coincident with that of the wire so that variation in diameter in a diametral section may also be investigated if so desired. It should be noted that in actual use the instrument and straight-edge shown in Fig. 3 should be firmly clamped to the surface plate. The necessary clamps have been omitted from the illustration for greater clarity.

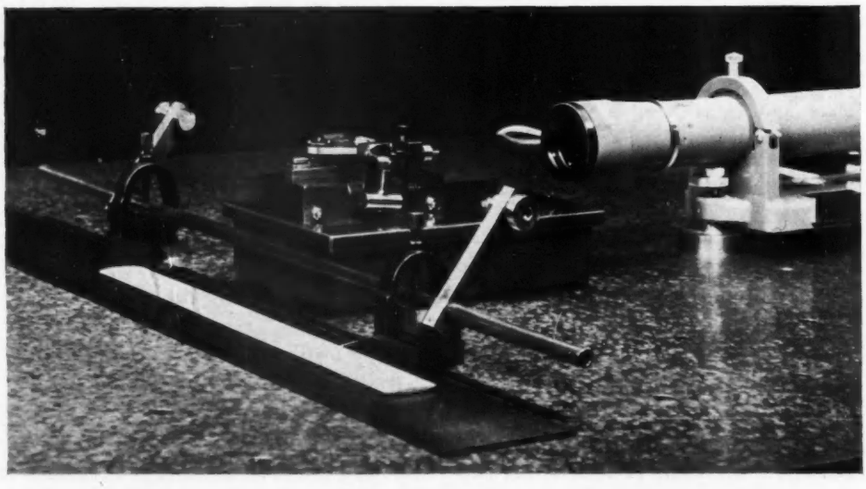

Fig. 3 The fixture on the left is for measuring diameters at different points along the wire.

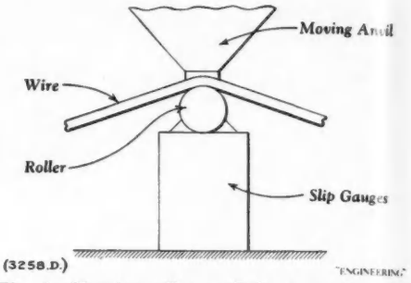

Fig. 4 Showing roller anvil for traversing wire longitudinally.

The use of the instrument at the National Physical Laboratory has so far been largely restricted to the measurement of diameter in the range 0·002 in. to 0·006 in. but absolute determinations of diameter have also been made successfully on wires of nominal diameter 0·000 15 in. using a contact load of about 1 gramme weight. A further application envisaged is the measurement of the diameters of small precision balls.

Acknowledgements.—The author wishes to acknowledge the assistance given by Mr. J. Wilson who constructed the instrument. The work described has been carried out as part of the research programme of the National Physical Laboratory and this communication is published by permission of the Director of the Laboratory.

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MICROPHONE FOR DUSTY ATMOSPHERES

Control in many steel mills is carried out from several consoles which have to be in communication with each other to co-ordinate operations. One of the problems encountered is that the atmosphere is heavily charged with ferrous dust which, by settling on the microphone diaphragm, can render the intercommunication system useless. To combat this, Tannoy Products, Limited, 348 Norwood-road, London, S.E.27, have produced a microphone with a diaphragm that is sufficiently robust to withstand a considerable deposit of iron dust without collapsing against the magnet under the attractive forces, but which will still give a performance equal to other types.

Due also to its robustness, the diaphragm can be cleaned at regular intervals by wiping with an oily cloth. To do this, the grille has been made removable and the work can be done by the service man during routine maintenance at intervals of, say, one month.

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On page 613 of the October 28 issue of ENGINEERING it was stated that Muroglass, manufactured by Pilkington Brothers, Limited, was available in standard lengths up to 100 ft. This should have read 100 in. Lengths greater than 100 in. can be supplied when required.

Fig. 1 The Perforation Department at Braby and Company's new factory at Crayford where steel plates, sheet lead, plastics and precious metal are handled.

STEEL FABRICATION

A NEW FACTORY AT CRAYFORD

Messrs. Fredk. Braby and Company, Limited, 352 Euston-road, London, N.W.1, have recently opened a new factory at Crayford, Kent, for the manufacture of sheet, plate and sectional metal products of many kinds. It replaces factories at Deptford and supplements others which have been built at Aintree, Glasgow and Bristol since the firm was established in 1839.

The new works cover an area of 28½ acres, have good railway and road connections, while a useful facility will be the Dartford-Purfleet tunnel, which starts nearby and gives direct access to the north. The buildings, which cover about 12 acres, are generally of framed construction (the steelwork for which was fabricated in the firm's Glasgow factory) and are faced with brick and Portland stone. Owing, however, to a shortage of steel, reinforced concrete has been used for the administration block and water tower. The layout is arranged so that materials enter the stores at one end and after undergoing the various manufacturing processes finally arrive in the Dispatching Department where they are loaded away under cover.

The workshops without cranes, such as the Perforation Shop, Tool Room and Galvanising Shop are generally 450 ft. long by 50 ft. wide by 22 ft. 6 in. high, while the Tank Plating Shop and Engineer's and Structural Departments are 550 ft. long by 50 ft. wide by 30 ft. high. Their appearance will be clear from the accompanying illustrations, of which Fig. 1 shows the Perforation Shop and Fig. 2 the Fabricated Platework Shop.

The former is equipped with a number of machines ranging from 350 ton presses for perforating steel plates up to 15 ft. long by 5 ft. wide several to small fast-running presses that perforate sheet lead, plastics and even precious metals. The Tank Department is equipped with a 150 ton press for producing cylinder ends, tops for hot and cold-water cisterns, and for oil tanks, while the products of the Sheet Metalwork Department, which is equipped with Argon arc welding equipment for dealing with non-ferrous metals, include ventilators, trunking and radiator casings. In the Galvanising Shop the three baths are coal-fired, the temperature of the metal being automatically controlled between 445 deg. and 465 deg. C. Ventilation is effected by 22 fans and there are a number of cranes and monorails for handling purposes. Other equipment consists of de-greasing, washing and pickling plant together with drying ovens which are heated to a temperature of 120 deg. F. by waste gases and into which the products are passed after galvanising. Vessels for containing liquids are then passed to an adjacent bay where they are pressure tested.

The Tank Plating Department is equipped with hydraulic presses for dishing and flanging circular ends up to 6 ft. in diameter by ½ in. thick, the main products being road wagon tanks, pressure vessels and hoppers, while in the Structural Department are the usual cropping, punching, straightening and radial drilling machines for structural steel work.

The water supply for general heating purposes is obtained from four oil-fired La Mont water tube boilers and is pumped to unit heaters controlled by thermostats in the factories and to coils, which are also thermostatically controlled, in the ceilings of the offices. A supply of electricity is drawn from the Area Board's mains at 11 kV and converted to 415 volts in three substations, each of which contains a 500 kVA transformer. The low-tension sides of these transformers feed into overhead aluminium busbars, with a carrying capacity of 1,000 amperes, from which 400 ampere spur bars run across the shops. Each transformer is equipped with a capacitor to correct the power factor to 0·98 lagging. Blended lighting is used throughout the works to give 8 to 10 lumens at working level. Compressed air for the entire factory is obtained from two compressors, one with an output of 600 cub. ft. per minute and the other giving half that amount; both are installed in the boiler house building. Acetylene is obtained from two 10 cwt. generators, and oxygen from a storage cylinder into which it is poured as a liquid at a temperature of − 183 deg. C. The pressure in the cylinders is 1,980 lb. per square inch and in the pipe lines 200 lb. per square inch.

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FLAMEPROOF FLASH EQUIPMENT

Restrictions on the use of standard electrical equipment has hitherto seriously limited taking flash lit photographs in underground coal workings. All types of flash equipment have to be synchronised with the camera shutter, and in conventional equipment the electrical energy supplied to the shutter synchronising contacts represents a quite unacceptable risk of ignition. To reduce this energy a special non-inductive triggering circuit has been used in the flameproof electronic flash equipment developed by Ernest Turner Electrical Instruments, Limited, High Wycombe, and further precautions have been taken so that even in the event of three internal faults the total energy in the external circuit cannot approach a potentially dangerous level.

The equipment is designed to give single flashes of white light of high intensity and short duration. The only external connection is made by a standard plug and socket to the synchronising contacts. The complete apparatus is contained in a cast aluminium-silicon housing designed as a flameproof enclosure and exempted from the restriction placed on the use of aluminium alloys at the coalface. The flash energy of the unit is 200 joules, and the average recovery time between flashes is 10 seconds; it weighs 58 lb. It is the subject of three certificates issued by the Ministry of Fuel and Power, and a certificate issued by the Factories Department of the Ministry of Labour and National Service covers its use in petroleum refineries.

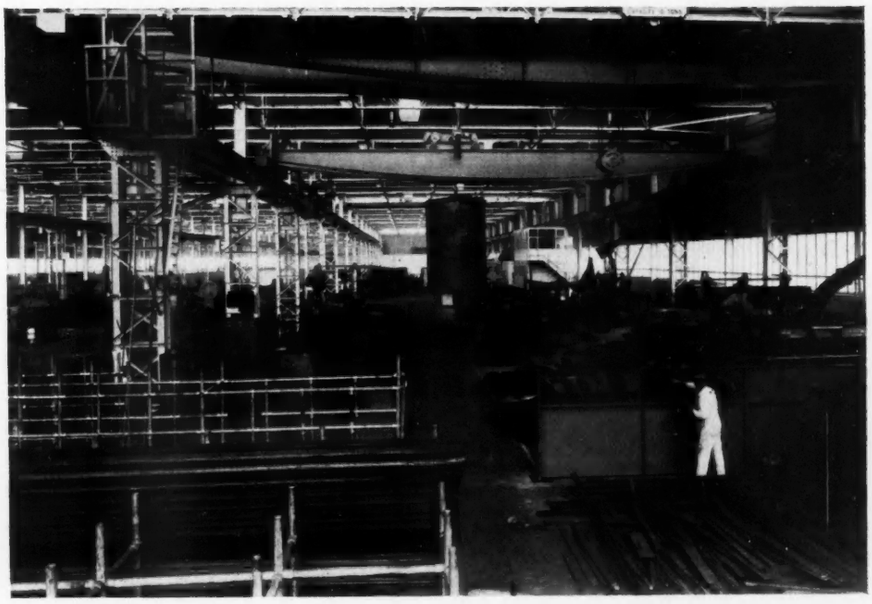

Fig. 2 A view in the Fabricated Platework Department in the same factory.

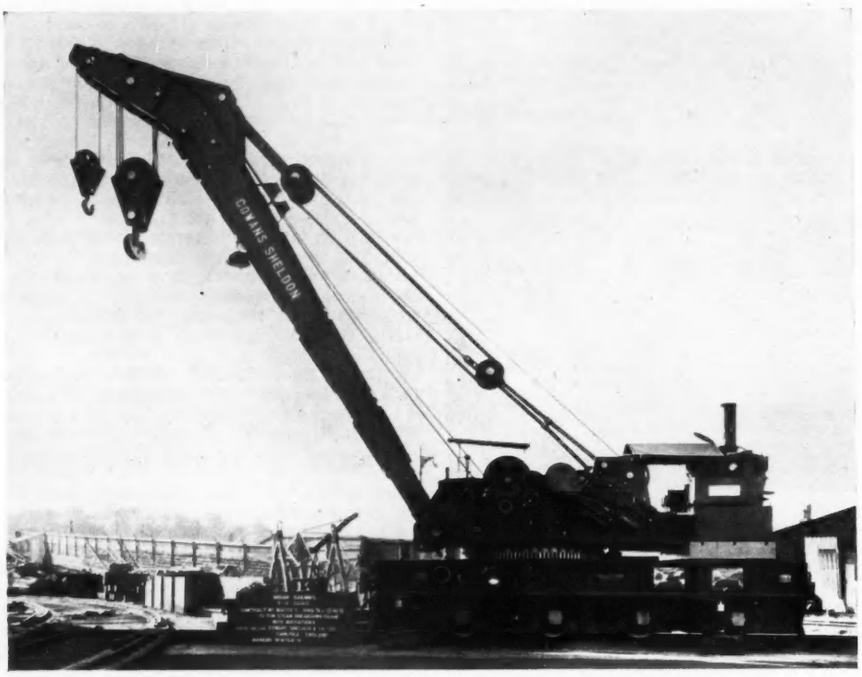

Fig. 1 Designed for a gauge of 5 ft. 6 in., these cranes are rated to lift 75 tons on the main block at 21 ft. radius.

75 TON BREAKDOWN CRANE

STEAM-PROPELLED SETS FOR INDIAN BROAD-GAUGE RAILWAYS

The first of seven 75 ton breakdown cranes for the Indian Railways recently underwent proving trials at the premises of its makers, Cowans, Sheldon and Company, Limited, Carlisle. The crane in working order is shown in Fig. 1 and arranged for travelling in train in Fig. 2.

The Indian track gauge is 5 ft. 6 in., which allows a greater freedom in design than is possible in this country. As a particular point in example of this, there is sufficient width on these cranes for the operator to stand at the foot of the jib, which allows him an excellent view of crane movement. He is protected by a removeable canopy. In front and at his right-hand side are the control levers or wheels for the various motions, and the jib radius indicator is in his direct line of vision. The canvas canopy has to be removed when the crane is travelling in train, as it would otherwise exceed the 14 ft. high loading gauge, and the chimney of the boiler also has to be lowered.

The permissible axle load of 16 tons did not allow the use of two three-axle bogies such as were used on the 65 ton cranes previously supplied. Instead, a pair of relieving bogies have been used, one at each end of the crane, to which is transferred part of the weight when travelling. A detail of one of these bogies is given in Fig. 3. In order to effect the weight transfer, two arms project from the crane truck and are joined at their extremity. A hydraulic jack acts below these arms and lifts them relative to the bogie and so transfers some of the weight from the crane truck to the bogie axles. Indicators and locking pins on the jacks show when the transfer is complete. When the whole crane in travelling order was put on the scales, it was found that the loads on the main axles ranged from 15 ton 6 cwt. to 15 ton 16 cwt. (as against a design estimate of 15 ton 15 cwt.) and the loads on the axles of the relieving bogies were 14 ton 17 cwt. and 15 ton 12 cwt. beneath the jib (designed figure 14 ton 9 cwt.) and 15 ton 10 cwt. and 15 ton 15 cwt. at the free end (against a design figure of 14 ton 18 cwt.). The two axles of the match truck (on which the jib head rests when lowered) totalled 26 ton 17 cwt. against the design amount of 25 ton 15 cwt. The totalled weight of the crane, bogies and truck as obtained by adding the axle loads was 150 ton 5 cwt., which compares quite favourably with the design value of 147 ton 9 cwt.

For travelling, the jib is lowered until it rests on the trestle of the match truck. Projecting pins on each side of the jib head contact the nearer edge of V-shaped slots in the side plates of the trestle and so draw the jib out from the jib foot pin. To facilitate travel on curves, the trestle on the match truck can swivel, but since it is undesirable that the whole crane turntable should be free to swivel when the set is travelling (for one reason the boiler end might project and foul the gauge limit, and correspondingly the jib might overhang inwards), the foot of the jib is pivoted in slots and not in circular bearings. This pivot arrangement is shown in the diagram in Fig. 3 and is a patent of the firm. In this way it is possible for the set to negotiate the standard curve of 573 ft. radius, and at slow speed a minimum curve of 450 ft. radius. The match truck, which was made by Hurst, Nelson and Company, Limited, Motherwell, is fitted with standard draw gear at both ends, and has in addition safety chains linking it to the relieving bogie. Since the main block is too bulky to manhandle into the well of the match truck, a set of hand-operated winch gear is provided, the handle for which is on the far side of the truck as shown in Fig. 2. The match truck also carries the tools, floodlights and similar items stored in lockers.

SPRINGS RELIEVED OF LOAD

The frame of the crane truck is built up from box-section beams made from heavy rolled-steel plates riveted together, with a heavy steel casting in the centre which carries the centre pin and the swivelling race. The four axles are mounted on semi-elliptical springs and carry solid disc wheels 2 ft. 9 in. in diameter. The journals are 12 in. long by 7 in. in diameter and run in gunmetal bearings lined with white metal and enclosed in cast-steel axle boxes. The four propping beams are carried below the frame and are extended by a rack and pinion mechanism, operated by a ratchet handle, as may be seen in Fig. 4. At the outboard end of each beam is a jack which can be screwed down to enter a cup mounted on a foot plate which will spread the loading on the ground. When fully extended on both sides, the distance between the opposite feet is 19 ft. 3 in. When preparing the crane for operation, before easing the jacks on the relieving bogies and so transferring the whole weight to the crane truck, screw jacks must be lowered to lock the axle springs, as these are only designed for travel loads. One of these jacks can be seen in Fig. 4, screwed down on to the spring. In this way the weight is transmitted directly through the axle to the rail, thereby preventing the spring from damage.

The crane superstructure which carries the jib, boiler, engine and gearing, is made from cheeks of heavy steel plates connected together by heavy structural steel stretchers. The whole turns about a steel centre post, and runs on 48 rollers arranged in a circle 9 ft. in diameter between steel pathways. The boiler is of the Hopwood multi-tubular type, 4 ft. 6 in. in diameter and 6 ft. 6 in. high over the crown plate. Its design conforms to the rules and regulations of the Indian Boiler Act. It is designed to work at 140 lb. per square inch and has a normal evaporation capacity of 890 lb. per hour which can be increased to 1,150 lb. per hour by hard steaming. Coal is used for firing and is stored in two boxes, one at each side of the boiler, with a total capacity of 10 cwt. Beneath the coal boxes are water tanks which provide storage for 250 gallons. The feed pump is separately mounted.

Steam is supplied to two cylinders, of 8 in. bore, both with pistons of 14 in. stroke, one on each side of the superstructure. They are fitted

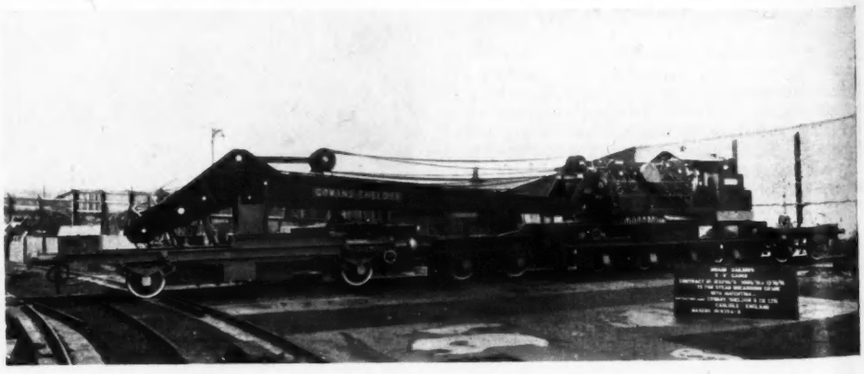

Fig. 2 For travelling in train, the jib rests on a match truck and the main carriage is jacked up to distribute some of the weight to the relieving bogies.

with Walschaert's valve gear and drive the main gear train to which the various motions are coupled by clutches. The various motions are: hoisting and lowering the main and auxiliary blocks; raising and lowering the jib; slewing; and rail travel. Both main and auxiliary hoists have two speeds and the change gears are side by side on a common shaft. The main block has three sheaves and uses wire rope $4\frac{5}{8}$ in. in circumference; it will lift 75 tons at 9 ft. per minute, or 35 tons at 18 ft. per minute. The auxiliary block has a single sheave and uses wire rope $3\frac{3}{4}$ in. in circumference to lift 15 tons at 45 ft. per minute or 7 tons at 90 ft. per minute. The maximum range of lift of the main block is 40 ft. at 21 ft. radius, being made up of 33 ft. above the rail level and 7 ft. below, while the auxiliary block goes 7 ft. higher at a radius of 24 ft. A foot brake with a "lock on" device is provided for the hoist gears.

The revolving motion is rack and pinion driven through a double cone friction clutch and reduction gear. With a full load of 75 tons, the crane can turn a complete revolution in two minutes. In actual trials, this speed was safely exceeded. The superstructure is locked when travelling to prevent slewing. The motion for raising the jib is similarly engaged by a clutch, and in this case the drive is through bevel, worm and spur gearing so that it is self-sustaining under all conditions of loading. The wire rope used for this is $4\frac{1}{8}$ in. in circumference reeved in 10 parts. The crane can propel itself if required at a rate of 220 ft. per minute when carrying a load of 18 tons, two axles being driven through dog-clutch, bevel and spur gearing. Sliding pinions in the train can be withdrawn by handwheels on the truck frame which can be reached from ground level. These disconnect the self-propulsion machinery so that the set can proceed in train free of gears. Steam brakes are fitted under the control of the driver, and also wheel-operated hand brakes for the ground staff. A system of through piping and couplings allows the crane set to be coupled in a vacuum-braked train, while not itself being under the control of these brakes.

The valid duties of the crane are as follows :—

(1) *Crane on level track.*

(*a*) With propping beams fully extended and jacked up: main block, 75 tons at 21 ft. radius; 35 tons at 30 ft. radius and 23 tons at 38 ft. radius. Auxiliary block, 15 tons at 42 ft. radius.

(*b*) Standing free on rails: main block 18 tons at 18 ft. radius. Auxiliary block, 15 tons at 21 ft. radius, decreasing to $4\frac{1}{2}$ tons at 42 ft. radius.

(2) *Crane on super-elevation not exceeding 5 in.* (radius measured as if standing level).

(*a*) With propping beams fully extended and jacked up: Main block 53 tons at 21 ft. radius, decreasing to 20 tons at 38 ft. radius. Auxiliary block, 13 tons at 42 ft. radius.

(*b*) Standing free on rails: Main block 13 tons at 18 ft. radius. Auxiliary block, 11 tons at 21 ft. radius, decreasing to 3 tons at 42 ft. radius.

During tests the crane successfully handled 25 per cent. above its rated loading, that is $93\frac{3}{4}$ tons instead of 75, and also proved its stability to be within the requirements that the tipping load should never be less than 128 per cent. of the rated load for the particular condition of working. Similarly it was checked for loading gauge and for travelling on curves.

So that there may be a clear field of action when on location, both the match truck and relieving bogies are fitted with lifting eyes, and the crane's first task will be to lift them clear. For general haulage use, a warping drum is fitted on one end of the main barrel pinion shaft, with which a wide variety of uses is possible. As the crane may have to be used at night as well as in daylight, an electric lighting system is incorporated, supplied by a turbo-generator driven from the boiler. Floodlights can be mounted on the jib and on each side of the main truck; there are also lights in the boiler compartment and over the driver's position, and there are sockets for supplying lead lamps. The boiler compartment has a fixed steel canopy and, as already mentioned, there is a removable canvas canopy over the driver's position which gives him some protection. Over the buffers of the relieving bogies the set measures 59 ft. 6 in. and the match truck adds another 32 ft. 11 in. to this, giving a total overall length of 92 ft. 5 in.

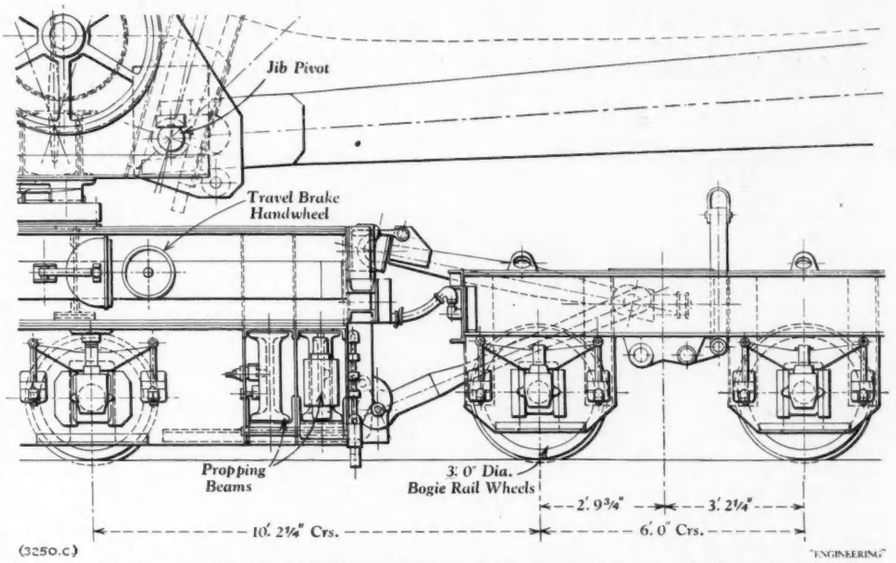

Fig. 3 Extension arms from the main carriage rest on jacks on the relieving bogies.

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LUBRICATION OF CRANE RAILS

A lubrication system to reduce wear on the wheel flanges and rails of travelling cranes has been made by Centralube Limited, Great Western Trading Estate, Park Royal-road, London, N.W.10. The general principle of the lubricator is shown in the accompanying illustration. The two applicator wheels each have a felt rim to apply the oil—generally a heavy machine oil—to the rail flanges. They are kept in position against the flanges partly by their own weight and partly by the tension of the spring between them.

Oil is fed from a "Multigreasor" with four outlets, which is driven from an eccentric on the travel shaft of the crane. Pipes and flexible hoses lead the oil to the pivot on which the felt rollers turn, and it reaches the outer edge of the rollers through centrifugal action during movement. The amount of oil used is small, and is claimed to be not more than $\frac{1}{4}$ to $\frac{1}{2}$ oz. per hour of operation. To obtain the best effects this system of lubrication should only be applied to rails in good condition.

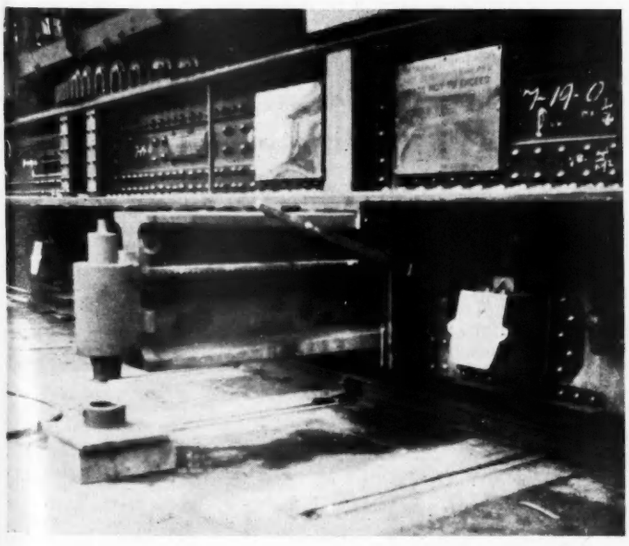
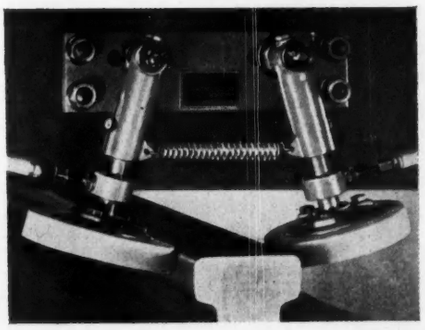


Fig. 4 The propping beams are carried below the main frame and extended by a ratchet operated rack and pinion. The screw jack to relieve the running spring can also be seen.



Oil is applied by the felt rollers to the flanges of the rails along which a travelling crane runs. A heavy machine oil is used, and consumption is claimed to be not more than $\frac{1}{4}$ to $\frac{1}{2}$ oz. per hour of operation.

PRODUCTION OF LAGGING

SLABS AND PREFORMED SHAPES MADE FROM ASBESTOS

Lagging plays a very important part in most industrial concerns as, by preventing radiation, it gives a saving in the fuel bill, as well as reducing the ambient temperature for the operators. Asbestos has excellent insulating properties, and the Cape Asbestos Company, Limited, produce thermal insulating material at their factory in Barking, Essex, in the form of board, slabs and moulded pipe sections.

The raw material comes in the main from the company's mines in South Africa where both blue and amosite forms are found. These have a fairly long stiff fibre, particularly suitable for insulation as it forms a resilient cushion. The blue form has the better resistance to acid attack. The other source of asbestos is Canada, but this is the chrysotile form which is much softer in texture and is short fibred. In Canada it is used in enormous quantities for plaster board and similar applications.

A certain amount of treatment is given to the asbestos at the mines and shipment to this country is made in sacks of graded material. The sacks are unloaded into barges which then bring them to the Company's wharf on the River Roding. There is room in the store shed for about 6,000 tons, or very approximately a year's supply at the present rate of use. Much of the material passes directly to disintegrators, which take the form of standard hammer mills, for fibrising, and is sold in this state to other producers of asbestos goods. Bagging is a problem owing to the fineness of the material, and rubberoid sacks are used for conveying it to the other factories of the company; experiments are being made with paper sacks for external sales. Throughout the factory dust extraction plant is fitted to keep the atmosphere clean, and it is so large that it requires almost as much power as the actual processing.

LAYERED SLABS

For making slab insulation, the asbestos is first "fibrised" in hammer mills made by Christy and Norris, Limited, Chelmsford. Owing to the abrasive nature of the material, manganese steel beaters are used and these have to be inspected about every two days, so great is wear on them. The material is hammered through screens which by their spacing determine the length of the fibres formed. Removed by suction, the material is separated in a cyclone and fed to a conveyor. This in turn delivers it to the slab-forming machines.

Fig. 1 Slabs, approximately 3 ft. square, are produced by a layering process. They are dried and then trimmed to size.

In these machines, a series of wooden trays passes below two feed hoppers and is carried on a conveyor belt. The upper plywood surface is waxed to prevent the asbestos from sticking. From the first hopper a layer of asbestos about ½ in. thick is spread on the trays, being distributed evenly by choppers. The trays then pass under a roller which consolidates the asbestos and then under a spray of sodium silicate which gives the bonding. These three processes are repeated starting from the second hopper, and the trays pass under a final roller before leaving the machine. A mechanical timing device ensures that the two hoppers receive equal amounts of material from the conveyor supply. At the end of the run the continuous layer is separated by hand at the junctions of the trays, a spare tray is placed on top of the slab, and the whole inverted by hand so that the dry bottom surface is uppermost and can be sprayed with sodium silicate. This slab is then passed by a parallel conveyor back to the starting point, from which it can either be returned to the machine if a greater thickness is required, or, by another process of inversion, transferred to wire-mesh trays and stacked on trolleys for drying. Because of the lightness of the material, both inversion processes are most conveniently carried out by hand. Completed slabs leaving the end of the conveyor are shown in Fig. 1.

TUBES FORMED BY MANDREL

The initial stages of the production of tubes for pipe insulation are identical with those for making slabs, but the forming machines are very different. Each has a single feed hopper from which the asbestos is spreading on to a slat conveyor, and sprayed with sodium silicate. At the end of the conveyor the mat is rolled on to a steel mandrel of the chosen size, as may be seen in Fig. 2. The indentations made by the conveyor slats materially assist in the consolidation of the asbestos mat. The process of winding on to the mandrel is continued until the correct thickness has been obtained, which is indicated by loose gauge rings slipped on to the ends of the mandrel. The completed moulding is then transferred to a finishing machine, where it rests on two rolls which revolve it under a third to give it smooth surface. At the same time, the exterior is sprayed with sodium silicate. When fully smoothed, the roll is laid in a half-cylindrical tray of sheet metal ready for drying and the mandrel withdrawn. The nominal size is marked on it and samples are weighed before and after drying.

The ovens in which both slabs and tubes are dried are similar and are fired by town gas. A combustion chamber is mounted above the oven tunnel and the hot gases are fed to the exit end through branched pipes. Guide plates direct the gas flow along the oven and at the entrance end the gases are recirculated to the combustion chamber. A small proportion is bled off to atmosphere and enough fresh air is added to supply the combustion process. At the entrance the oven temperature of the gases is approximaterly 450 deg. F. falling to about 150 deg. F. when they are withdrawn. This gives an average oven temperature of 300 deg. F. The period required to dry the slabs and tubes depends on the thickness of the asbestos and varies from 2 to 12 hours. Both slabs and tubes are stacked on trolleys which are drawn out of the ovens by a winch when the drying time is completed. Fig. 3 shows a trolley load of tubes being withdrawn. The loaded trolleys are then wheeled away over the steel-slab floor and allowed to cool.

TRIMMINGS RETURNED FOR USE

Standard slab sizes are 3 ft. by 3 ft. and 3 ft. by 4 ft. In both cases the rough slabs are placed in trimming machines where a double-chain conveyor with projecting fingers carries

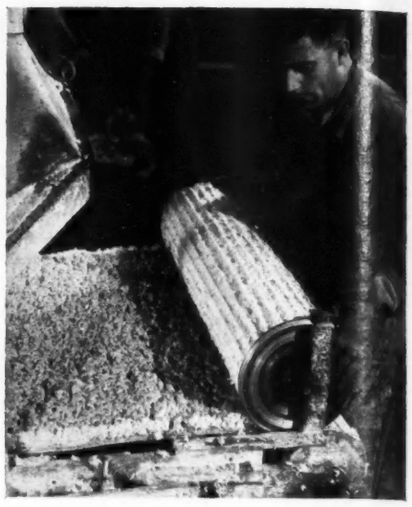


Fig. 2 Tubes are made by rolling a laid mat on a mandrel till the required thickness is obtained. The surface is afterwards smoothed on rollers.

them between two circular saws. On each side of the machine, the trimmings fall on to a canvas belt which moves them to an integral pulveriser. The action require that, as the trimmings come forward on the belt, they are gripped by a second spring-loaded inclined belt and their edges presented to a rotating drum. On the surface of this drum are cutters which reduce the trimmings to the "fibrised" condition. This material is then conveyed to sacks by an air lift, and can be fed back into the process so that wastage is very small indeed. Some of the slabs are cut into thin strips by bandsaws, for use in insulating bodies of large curvature or small size.

Pipes pass through a similar trimming machine, but the integral disintegrator has not yet been added and the trimmings are removed in sacks for pulverising in other machines.

When the tubes have been trimmed, they roll into a trough where a conveyor moves them axially (at right angles to their previous motion) into a chamber where they are slit along their length by a bandsaw. This process is shown in Fig. 4. After being slit, the two halves are parted, as shown, and any dust from the cutting operation is blown away by the compressed air

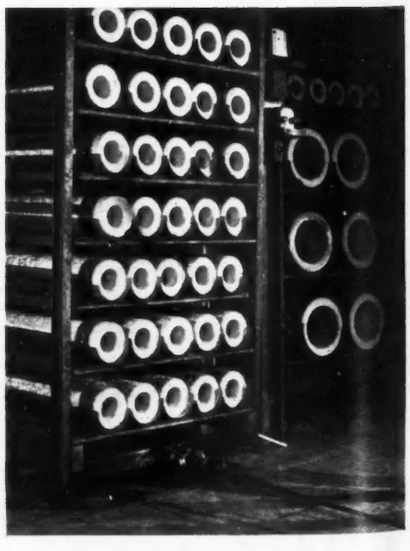


Fig. 3 The trolleys carrying stacks of slabs or tubes are withdrawn from the drying ovens by a winch and then left to cool.

Fig. 4 After being trimmed for length, tubes are slit longitudinally so that they can be fitted round pipes. Air jets blow the dust from the interior.

which issues from the jets mounted above. Dust extraction plant is fitted in the machine. The present plant is now in process of replacement, and fully automatic machines which will handle tubes up to 36 in. in diameter are to be installed. The slitting of the tubes is a necessary process to enable them to be fitted around existing pipework; it is also necessary that the halves should be completely interchangeable. For some applications, the two halves are hinged together by a strip of calico stuck on to them by starch paste, but in general they are held together on the pipe by a ring of strip metal. Special shapes for flanges, elbows, bends and the like, are cast in moulds as required.

MILLBOARD

Millboard is also made at Barking, but for this the raw material is chrysotile from Canada and not amosite. The fibres, mixed with starch and china clay, are churned in a large vat to form a thick slurry. This is passed to agitated storage tanks and greatly diluted with water. The resulting suspension is pumped to tanks which provide a constant head for feeding the forming machines. In the machines, the slurry is kept in large tanks, in which are mounted revolving drums of fine gauze. There is a constant passage of liquid into these (from which it is continuously extracted), and in its passage through the gauze a very thin layer—about 0·005 in.—of the asbestos mixture is deposited. Over the top of the drums there passes a canvas belt which is pressed down on to the drums by rollers and which carries the deposited mat away with it. One of the machines has three drums and the other two; so that in one case there are three layers of mat deposited on the canvas and in the other only two. On its return journey the canvas belt passes in succession over two vacuum boxes which extract a good deal of the moisture from the mat. The latter is then wound off on to a large drum.

Millboard can be produced on these machines in any thickness up to ½ in. The size of the sheets is limited by the circumference of the winding drum and is something over 3 ft. square so that the final size is 40 in. by 40 in. Boards of greater thickness than ½ in. can be obtained, simply by sticking two thin boards together with starch. On the winding drum of the machine is a device which measures the thickness of the layer wound up, by means of a floating roller. When the set thickness is reached, a warning bell rings, a cut is made across the mat and compressed air cylinders raise one end of it so that it is fed off on to a receiving conveyor. The sheets are then interleaved with woven plastic cloths and stacked in a press. After squeezing, the sheets are clipped to the cloths and hung separately in a trolley-mounted frame for drying. Because of the presence of the starch, the drying temperature must not exceed 250 deg. F. as above this browning takes place. therefore steam heat exchange ovens are used. After drying, the thinner sheets are trimmed by standard guillotines and by saws for the thicker grades.

SPECIALISED MACHINES

One of the difficulties that the company has experienced is obtaining the specialised machines required for the processes. Consequently, they have built up a design section and machine shop to design and produce their own. This shop also is responsible for the maintenance of the plant. Selected apprentices are taken, at present there are six, for general and special training. The company also have a large sheet-metal shop where sleeving is made for covering the lagging at various installations, and all ducting work is done. In addition, they design and manufacture their own fans. Quality control of the finished product is checked in the laboratory which is fully equipped for carrying out conductivity tests on all types of material. The company has 13 other factories where different products are made. Spinning and weaving is carried out at Acre Mill in Yorkshire, and some of the cloth is made up into filled mattresses at Barking. Other factories are in Scotland, Benoni (Transvaal) and Turin. Progress is now being made towards establishing a new factory in Canada.

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AUTOMATIC CONTROL OF HELICOPTERS

Lightweight Electronic Unit

A miniature " fail-safe " flight-control system for helicopters has been developed by the aeronautical equipment division of the Sperry Gyroscope Company Division of Sperry Rand Corporation, Great Neck, New York.

The new electronic aid for pilots of rotorcraft provides greatly simplified manual control or completely automatic operation for hovering. The basic units of the Sperry systems weigh only 60 lb., including automatic trim devices, altitude and speed controls.

Small electronic " brain cells," employing transistors, magnetic amplifiers, and latest miniature circuit techniques, command electric or hydraulic " muscles " to manipulate the helicopter's manoeuvering mechanism. The plug-in " brain " units compute combinations of signals from various sources: from force and motion sensors to assist manual control; from sensitive gyros and compact electronic couplers for automatic operation.

Flexible combinations of these modular units make possible various control systems to suit many types of helicopters for various civil and military applications.

The system provides five channels of automatic control, through a single set of primary cockpit controls similar to the ordinary control column, rudder pedals, and collective pitch lever. This integrated combination gives the pilot full freedom for manual manoeuvering, yet at the same time provides fail-safe automatic stability at all speeds including full-cruise, hovering, and " engine out " auto-rotation.

In manual-automatic operation, the gyros automatically stabilise the aircraft on its existing flight path. While the pilot relaxes " hands off," control elements measure and hold desired the altitude, speed, or climb positions. To change the flight path, the pilot applies pressure to the control as in manual flight. Sensors " feel " this command and signal the automatic system to respond as ordered. When the pilot commands a turn, the system automatically banks the aircraft at the angle necessary to prevent slip or skid during the turn.

For automatic hovering, couplers could accept signals from inertial devices in the aircraft, or from submerged sonar units, ropes, cables, or ground command signals via radio or wire. The system automatically maintains altitude and heading.

The system also permits pilotless operation, such as might be required for an unmanned helicopter to lift special devices or radar antenna over a tactical position.

A compact engine control developed jointly with the United States Air Force Wright Air Development Command automatically maintains constant rotor speed, relieving the pilot of the need for adjusting the throttles for every small change in rotor lift or loading. Working compatibly with this control is a mechanism that automatically controls the aircraft altitude according to barametric pressure, hydrostatic pressure, or other special electronic signals. At all times, a pilot's command can " over-ride " the system—such as climbing over a hill or an island—later releasing the command to allow the altitude control to bring the machine back on the previously-set altitude level.

Failure-proofing of the system is accomplished by a technique called " redundant amplification." Each small electronic " brain cell " is actually two amplifiers contained in a unit not much larger than a matchbook. Should one amplifier fail, the other carries the load with no appreciable change in performance.

Should the helicopter engine fail, the system remains operative, during the engine-out glide, on a small fraction of the reserve electric power available from the aircraft's storage battery.

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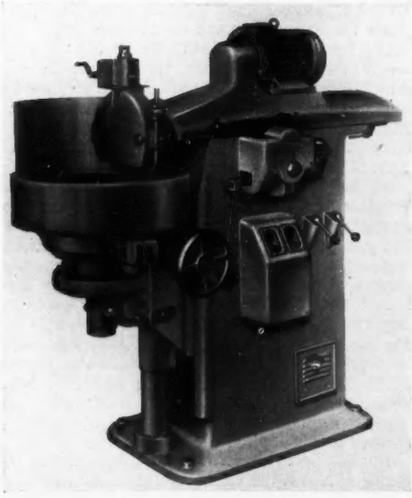
ROTARY SURFACE GRINDER

The new Slipmaterial-Naxos surface grinder, which is illustrated herewith, is of Swedish manufacture; it is marketed in this country by the Mortimer Engineering Company, 210 Actonlane, Harlesden, London, N.W.10.

The machine has a horizontal wheel-spindle, carrying a grinding wheel of 12 in. by 2 in. by 5 in. maximum size, which runs at 2,070 r.p.m. It is driven by an 8 h.p. motor through V-belts. The work is carried by a magnetic chuck on a rotating work-table, which can be tilted up to 5 deg. in either direction for concave or convex grinding. A separate motor, of 2 h.p., drives the work-table, by means of a V-belt and gearing. The table accommodates work up to a maximum of 20 in. diameter and 12 in. high. Feed is hydraulic, and is applied automatically at each revolution of the work-table. Grinding depths can be pre-set and the feed cuts out automatically at this point. A separately-driven coolant pump, with a 40 gallon tank, is built into the machine.



A rotating work-table with a magnetic chuck, hydraulic feed and easy access to the work, make the Swedish Slipmaterial-Naxos grinder adaptable for a number of grinding operations.

In Parliament

POST OFFICE ENGINEERING DEVELOPMENTS

Capital expenditure for Post Office requirements was discussed in the House last Friday on the second reading of the Post Office and Telegraph (Money) Bill, which was moved by Dr. Charles Hill, the Postmaster-General. He said that Post Office investment, both for new developments and replacements, had been substantially curtailed since the war but that, after making allowance for restraint in line with Government policy, the average capital investment for the next three years would be £100 millions a year, inclusive of replacements.

Since 1939, the Department had been gradually mechanising the trunk services. Within the next four years further automatic trunk exchanges would be built at Birmingham, Bristol, Carlisle, Chester, Leicester, Manchester, Middlesbrough, Nottingham, Portsmouth and Swansea. On the horizon was the mechanisation of trunk services to enable subscribers to dial trunk calls everywhere. Suitable equipment was being designed and, in a foreseeable time, it would be introduced. A number of changes would be involved, including the provision of mechanical account keeping, but they would bring immense efficiency. The initial installation would be at Bristol and it was planned to bring this equipment into service in the spring of 1959.

In round figures, Dr. Hill said, £1 million of the money to be voted would be used to provide coaxial cables to connect the new television stations which were to be opened and that included cables for both the I.T.A. and the B.B.C.

Captain L. P. S. Orr (Ulster Unionist) said he had information which seemed to show an extraordinary disparity between the cost of providing carrier telephony in Britain and in the United States. In Britain, this equipment cost £2,000 a channel, but, in the United States, similar equipment was provided for about £200.

The provision of such equipment for the Post Office, he said, was in the hands of a tight ring, dominated by a wholly American-owned company, which, he understood, had permission from the Treasury to export all the profits in dollars to the United States. The magnitude of these exceeded the total exports to the United States of Britain's electronics industry.

TENDERS FOR CHIEF JOSEPH DAM

Questions regarding the rejection of British tenders in the United States came before the House on November 10. One was an inquiry as to what answer had been received from the State Department to the written representations made by Sir Robert Scott, the British Minister in Washington, regarding the tenders for the Chief Joseph Dam and the other, a request for a statement about the rejection by the United States Government of a lowest tender for an electrical undertaking, which was submitted by a United Kingdom firm.

In his answer, Mr. Peter Thorneycroft, the President of the Board of Trade, said that the State Department defended the action taken on the ground that the contract was to be carried out in the United States in an area of substantial unemployment. The United States reply also stated that the decision did not represent a departure from the principles laid down in the President's executive order of December 1954, or from the declared objectives of the United States Government to pursue a liberal foreign-trade policy. He did not consider that any useful purpose could be served by replying further to the United States note.

Mr. E. Fernyhough (Labour), who asked the question about the Chief Joseph tender, pointed out, in a supplementary question, that, since the tender was rejected, the United States had increased the import duties on British bicycles and had recently increased the duty on underground pipes. Did not this make nonsense of America's promise to liberalise trade? Mr. Thorneycroft answered that he had made his views quite clear regarding these various actions by the United States. Indeed, they had come under considerable criticism from newspapers in that country.

(Editorial comment on the rejection of the British tender was contained in a Weekly Survey note on page 323 of our issue of September 9. On November 14, however, it was reported that the English Electric Company had obtained a contract to supply transformers to Idaho, to the value of 106,000 dols.)

AUTOMATION, INJURIES AND ROADS

Among a number of private members' Bills read a first time on November 9 and ordered to be printed was one on automation and electronics. The Bill seeks to provide for the establishment of a permanent committee "to inquire into, review and report" on the social, educational, cultural and economic needs and consequences of the application of automation and electronic devices to British industry and agriculture. It was presented by Mr. R. Edwards and will be read a second time on December 9.

Industrial injuries were the subject of two of the Bills. One, the Workmen's Compensation (Supplementation) Bill, seeks to provide for the payment of allowances out of the Industrial Injuries Fund to workmen to whom the Workmen's Compensation Acts apply, and the other is a proposal to further amend the National Insurance (Industrial Injuries) Acts, 1946 to 1954, in relation to increases of disablement pension in respect of the special hardship allowance and unemployability supplement. The first was presented by Mr. George Deer (Labour) and the second by Mr. R. Mason (Labour). They will both be read a second time on February 17, 1956.

A Bill was presented by Mr. C. N. Thornton-Kemsley (Liberal-Unionist) to authorise local authorities in Scotland to contribute to the expenses of frontagers and others in connection with the construction and maintenance of private roads and another was put forward by Mr. A. E. Baldwin (Conservative) to make provision for the improvement of transport in rural areas by rail, road and water. The former was the Local Government (Street Works) (Scotland) Bill, to be read a second time on November 25, and the latter, the Rural Transport Improvement Bill, which will be read a second time on December 9.

Another Bill aims at changing to "public health inspector" the designation of sanitary inspectors appointed under the Local Government Act 1933, or the London Government Act 1939, and was presented by Sir W. Wakefield (Conservative). It will be read a second time on March 2 next year.

Sandwich Courses in Engineering

Asked the number of students at present enrolled at technical colleges in sandwich courses in engineering and applied science, the Minister of Education, Sir David Eccles, replied that, during the 1954-55 session, 1,522 students took a variety of these courses, leading to different levels of qualification. Figures were not available for the present session but it was known that a number of additional courses had been started. On the following day, the Secretary of State for Scotland, Mr. James Stuart, said that sandwich courses in engineering and technology were in operation at the Royal Technical College, Glasgow, the Heriot-Watt College, Edinburgh, and at Paisley Technical College.

Shipment Facilities for Motor-Cars

The attention of the Minister of Transport and Civil Aviation was drawn to the special facilities being provided by German shipbuilders for the transport of motor-cars, which enabled vessels to carry a much larger number of cars by the fixing of additional floors and he was asked if British shipbuilders might receive permission to provide similar facilities on British vessels. Mr. John Boyd-Carpenter wrote that there was no objection to the installation of fittings of that kind on British ships, provided that they were so arranged as not to endanger the safety of the ships or their crews.

Science Facilities in Schools

In answer to a question by Mr. Austen Albu (Labour), Sir David Eccles wrote that the cost of building laboratories at schools could not be separated exactly from the cost of the new schools, of which they formed an integral part. But he estimated that, since 1945, the laboratories alone had cost £1,500,000 in technical schools, £3 million in grammar schools and £9 million in modern schools.

Call-up Deferments of Engineering Apprentices

Replying to a question urging that the call-up of men engaged in the export industries be deferred in suitable cases, the Minister of Labour and National Service, Sir Walter Monckton, stated that two years' deferment of call-up was already granted to ex-apprentices employed on certain highly-skilled engineering and ship-building work of particular importance to exports, and that he could not see his way to extend that arrangement.

London Railway Electrification

Mr. Boyd-Carpenter said that he had been informed by the British Transport Commission that a scheme for the electrification of the Liverpool Street to Enfield Town railway line had been approved in principle and that detailed planning was well advanced. As to when the work was likely to be begun, he preferred not to anticipate the Commission's two-yearly forecast of work to be done, the next edition of which would be issued early in 1956.

London-to-Yorkshire Trunk Road

A question was asked by Sir Leonard Ropner (Conservative) inquiring as to the progress which had been made in the construction of the London-to-Yorkshire trunk road. Mr. Boyd-Carpenter said that, in respect of that part of the motorway which would run from the St. Albans by-pass to near Ashby St. Legers, the draft scheme required by the Special Roads Act had been published in the week beginning September 19. The scheme in respect of the St. Albans by-pass would be published on November 21. Sir Owen Williams and Sons had been appointed as consulting engineers to prepare the engineering details of the road and to supervise the carrying out of the work which would be done by contract. (A comment on this scheme was contained in our issue of September 30, page 443.)

He added, in answer to a supplementary question, that the scheme for the London-to-Yorkshire road having been published, the statutory period for objections was now running and that, until it was known what objections there were, if any, it would be unwise to give a forecast as to when the road would be completed.

Non-Skid Road Surfaces

Mr. Boyd-Carpenter stated that, in conjunction with the Road Research Laboratory, his Department was investigating the economy and durability, as well as the non-skid qualities, of some 1,500 different compositions of road surfacing. In addition, periodical skidding tests were carried out on existing roads. The results of these investigations were published from time to time by the Road Research Laboratory. In cases where the question of grants arose, it was the duty of his Department to see that the most suitable surfaces were used. He agreed that he was aware of the danger of riding on zebra crossings in wet weather.

Glasgow Factory Dispute

Sir Walter Monckton, the Minister of Labour and National Service, answering a question as to whether he would intervene and assist in a settlement of the strike at the Rolls-Royce works in Glasgow, replied that there was an agreed procedure in the engineering industry for the settlement of disputes. The procedure was not at present operating in that dispute owing to the stoppage of work, but the Ministry's industrial relations officer in Scotland was keeping touch

NOTICES OF MEETINGS

British Interplanetary Society

GLASGOW
"The Rocket Engine and Its Problems," by A. V. Cleaver. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Fri., Nov. 25, 7.30 p.m.

Building Centre

LONDON
Film: "Power Tools in the Building Industry." Wed., Nov. 23, 12.45 p.m.

Chemical Society

ABERDEEN
Liversidge Lecture on "Reactions of Radicals in Gaseous Systems," by Dr. E. W. R. Steacie. Aberdeen Branch. Chemistry Department, Aberdeen University, Old Aberdeen. Thurs., Nov. 24, 7.45 p.m.
BELFAST
"Preparation and Use of Radio Isotopes in Industry and Medicine," by Dr. G. B. Cook. Northern Ireland Branch. Queen's University, Belfast. Tues., Nov. 22, 7.15 p.m.
BRISTOL
"Magnetism and the Shape of Inorganic Molecules," by Professor R. S. Nyholm. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., Nov. 24, 5.15 p.m.
NEWCASTLE-UPON-TYNE
"The Relation Between Theory and Experiment in Physical Chemistry," by Professor E. A. Guggenheim. Newcastle and Durham Branch. Chemistry Building, King's College, Newcastle-upon-Tyne, 1. Fri., Nov. 25, 5.30 p.m.

Engineer Buyers and Representatives Association

LONDON
"The Lighter Side of Science," by Professor A. M. Low. London and Home Counties Branch. Gargoyle Club, 69 Dean-street, W.1. Fri., Nov. 25, 7 p.m.

Illuminating Engineering Society

LONDON
"Ship Lighting," by T. Catten. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Tues., Nov. 22, 6 p.m.*
BATH
"Maintenance of Lighting Installations," by A. D. S. Atkinson. Bath and Bristol Centre. Offices of the South Western Electricity Board, Old Bridge-street, Bath. Fri., Nov. 25, 7 p.m.
LIVERPOOL
"Studies in Interior Lighting," by J. M. Waldram. Liverpool Centre. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Tues., Nov. 22, 6 p.m.

Incorporated Plant Engineers

CARDIFF
Address by Sir Oliver Lyle. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., Nov. 22, 7.15 p.m.
CHESTER
Informal Discussion Meeting. Merseyside and North Wales Branch. Grosvenor Hotel, Chester. Thurs., Nov. 24, 7.15 p.m.
SHEFFIELD
Discussion on "The Treatment of Effluents." Sheffield Branch. Grand Hotel, Sheffield. Thurs., Nov. 24, 7.30 p.m.

Institute of British Foundrymen

NORTHAMPTON
"Cores and Moulds by the CO_2 Process," by A. Talbot. Northampton Section. Plough Hotel, Northampton. Thurs., Nov. 24, 7.30 p.m.
SOUTHAMPTON
"Recent Developments in High Chromium Cast Iron," by H. P. Hughes and J. Monaghan. Southampton Section. The Technical College, St. Mary's-street, Southampton. Thurs., November 24, 7.30 p.m.

Institute of Fuel

LONDON
"Modern Industrial Dust Collection," by C. J. Stairmand. Institution of Civil Engineers, Great George-street, S.W.1. Wed. Nov. 23, 5.30 p.m.*
BIRMINGHAM
"Industrial Aspects of the Beaver Report," by G. Nonhebel. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Thurs., Nov. 24, 6 p.m.
LIVERPOOL
"Some Problems in Domestic Heating," by J. S. Hales. Merseyside Sub-section. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Thurs., Nov. 24, 7 p.m.

Institute of Industrial Supervisors

GLASGOW
"Isotopes in Industry," by Dr. H. Seligman. Glasgow Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Nov. 21, 7.30 p.m.
LEICESTER
"Labour Cost Control," by G. M. Storey. Offices of Partridge, Wilson & Co., Ltd., Leicester. Wed., Nov. 23, 7.30 p.m.

Institute of Marine Engineers

LONDON
"Full-Scale Fatigue Tests of Diesel-Engine Elements," by P. E. Wiene. Tues., Nov. 22, 5.30 p.m.*

Institute of Marine Engineers and Institution of Naval Architects

PORTSMOUTH
"Forty Years of Change at Portsmouth Dockyard," by I. E. King. Southern Joint Branch. Portsmouth College of Technology, Anglesea-road, Portsmouth. Thurs., Nov. 24, 7.30 p.m.

Institute of Refrigeration

LONDON
"Problems Connected with the Cooling of the Human Body by Means of Mechanical Refrigeration," by L. Cowley. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Nov. 24, 5.30 p.m.

Institute of Road Transport Engineers

DURHAM
"Ability to Stop," by H. Clements. North Eastern Centre. Three Tuns Hotel, Durham City. Tues., Nov. 22, 7 p.m.

Institution of Civil Engineers

LONDON
"Prestressed Concrete as Applied to Building Frames," by Francis Walley and H. C. Adams. Structural and Building Division. Tues., Nov. 22, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "The Reception of Band I and Band III Television Programmes," opened by E. P. Wethey. Radio and Telecommunication Section. Mon., Nov. 21, 5.30 p.m.*
"Flat Pressure Cable," by J. S. Møllerhøj, A. M. Morgan and C. T. W. Sutton. Supply Section. Wed., Nov. 23, 5.30 p.m.*
"Electrical Measurement of Mechanical Vibrations," by D. E. Mullinger. London Graduates' and Students' Section. Tues., Nov. 22, 6.30 p.m.*
CHESTER
"Control of Direct-Current Machines," by E. P. Hill and A. A. L. Bentall. Mersey and North Wales Centre. Town Hall, Chester. Mon., Nov. 21, 6.30 p.m.
GLASGOW
"Highland Water Power," by the late T. Lawrie. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Nov. 23, 7 p.m.
LOUGHBOROUGH
"The Electrical-Engineering Industry in the Post-War Economy—II," by G. L. E. Metz. East Midland Centre. Loughborough College, Loughborough. Tues., Nov. 22, 6.30 p.m.
SALISBURY
"The Recent Search for and Salvage of the Comet Aircraft Near Elba," by Commander C. G. Forsberg and G. G. MacNeice. Southern Centre. Offices of the South Eastern Electricity Board, Salisbury. Wed., Nov. 23, 6.30 p.m.
WEYMOUTH
"Atomic Energy," by H. Lysons. Southern Centre. South Dorset Technical College, Weymouth. Fri., Nov. 25, 6.30 p.m.

Institution of Engineering Inspection

MANCHESTER
"The Lost-Wax Process of Investment Casting," by W. N. Jones. Manchester Branch. Engineers' Club, Albert-square, Manchester. Thurs., Nov. 24, 7.30 p.m.

Institution of Heating and Ventilating Engineers

EDINBURGH
"Heating Engineers and Fuel Efficiency," by H. H. Grattidge. Scottish Branch. 25 Charlotte-square, Edinburgh. Tues., Nov. 29, 7 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "Front or Rear Engine?" Automobile Division. Wed., Nov. 23, 6.45 p.m.*
"Developments in Mechanised Welding in the Aero-Engine Industry," by F. G. C. Sandiford. Industrial Administration and Engineering Production Group. Fri., Nov. 25, 5.30 p.m.
BASINGSTOKE
"The Running-in of Engines: Choice of Cylinder-Bore Finish," by Dr. S. G. Daniel and Dr. K. R. Williams. Southern Branch. Canteen of Transport Equipment Ltd., Basingstoke. Wed., Nov. 23, 7.30 p.m.
BIRMINGHAM
"Some Aspects in the Design and Performance of Small Diesel Engines," by B. W. Millington and M. H. Howarth. Birmingham A.D. Centre. James Watt Memorial Institute, Great Charles-street, Birmingham. Tues., Nov. 22, 6.30 p.m.
BRISTOL
"Disk Brakes," by F. G. Parnell and F. J. Bradbury. Western A.D. Centre. Royal Hotel, Bristol. Thurs., Nov. 24, 6.45 p.m.
HALIFAX
Discussion on "The Use and Misuse of Large Boring Machines," introduced by R. Hallam. Yorkshire Branch. White Swan Hotel, Halifax. Wed., Nov. 23, 7 p.m.
LEICESTER
"The Application of Atomic Energy to Power Production," by Dr. S. C. Curran. East Midlands Branch. College of Technology, Leicester. Wed., Nov. 23, 7.30 p.m.
LUTON
"The Impact of Development and Research on Production and Design," by L. H. Leedham. Eastern Branch. Town Hall, Luton. Tues., Nov. 22, 7.30 p.m.

Institution of Production Engineers

BRISTOL
"Shipbuilding in Bristol," by Richard Hill. Western Section. University Engineering Laboratories, University-walk, Bristol 8. Wed., Nov. 23, 7.15 p.m.
CARDIFF
"The Trade Union in Engineering Production," by T. Wylie. South Wales Section. South Wales Institute of Engineers, Park-place, Cardiff. Fri., Nov. 25, 7 p.m.
HALIFAX
"Men and Machines," by J. E. Hill. Halifax Section. White Swan Hotel, Halifax. Tues., Nov. 22, 7.15 p.m.
LINCOLN
"Control of Quality in Medium-Quantity Production," by J. Loxham. Lincoln Section. Ruston Club, Unity-square, Lincoln. Thurs., Nov. 24, 7.30 p.m.
NEWCASTLE-UPON-TYNE
"The Development and Achievement of the Vickers Viscount," by A. H. C. Greenwood. North Eastern Section. Neville Hall, Newcastle-upon-Tyne. Mon., Nov. 21, 7 p.m.

Institution of Railway Signal Engineers

LONDON
Discussion on "Point Control and Detection," opened by J. H. Tyler. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., Nov. 22, 6 p.m.*

Institution of Structural Engineers

LONDON
Discussion on "Structural Safety." Thurs., Nov. 24, 6 p.m.
BIRMINGHAM
"Prestressed and Other Reinforced-Concrete Works at Ansells Brewery," by J. E. C. Farebrother. Midland Counties Branch. James Watt Memorial Institute, Birmingham. Fri., Nov. 25, 6 p.m.*

Institution of Works Managers

NOTTINGHAM
Discussion on "A Case Study on Industrial Engineering Problems." Notts and Derby Branch. Bell Inn, Nottingham. Fri., Nov. 25, 7.30 p.m.

Junior Institution of Engineers

LONDON
Annual General Meeting. Fri., Nov. 25, 7 p.m.

Liverpool Engineering Society

LIVERPOOL
"Refacing of Four Concrete Dams with Gunite, Trawsfynydd Reservoir, North Wales," by W. G. Ternan. Wed., Nov. 23, 6 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"An Analysis of the Behaviour of Riveted Joints in Aluminium Alloy Ships' Plating," by Dr. A. R. Flint. Mining Institute, Newcastle-upon-Tyne. Fri., Nov. 25, 6.15 p.m.

Reinforced Concrete Association

BIRMINGHAM
"Reinforced and Prestressed Concrete at Ansells Brewery," by J. E. C. Farebrother. Midland Counties Branch. James Watt Memorial Insitute, Birmingham. Fri., Nov. 25, 6 p.m.*
GLASGOW
"Developments in Technique of Precasting Concrete Structures," by J. A. Derrington. Scottish Branch. St. Enoch Hotel, Glasgow. Thurs., Nov. 24, 6.30 p.m.*

Royal Aeronautical Society

LONDON
"Aviation Journalism," by Charles Gardner. Tues., Nov. 22, 7 p.m.

Royal Institution

LONDON
"Lightning and the Long Electric Spark," by Dr. B. F. J. Schonland. Fri., Nov. 25, 9 p.m.

Royal Meteorological Society

LONDON
"Fog and Atmospheric Pollution," by P. J. Meade. Fri., Nov. 25, 5 p.m.*
EDINBURGH
"The British North Greenland Expedition 1952-54," by R. A. Hamilton. Scottish Centre. Department of Natural Philosophy, The University, Drummond-street, Edinburgh. Fri., Nov. 25, 5 p.m.*

Royal Society of Arts

LONDON
"Science of Brewing," by Dr. A. H. Cook. Mon., Nov. 21, 6 p.m.
"Research in Industry," by Dr. B. K. Blount. Wed., Nov. 23, 2.30 p.m.

Royal Statistical Society

GLASGOW
"Use of Statistics in the Study of Market Developments," by J. V. Gregg. Glasgow Industrial Applications Group. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Nov. 24, 7.15 p.m.
SHEFFIELD
"Consumer Preference Testing," by N. J. Squirrell. Sheffield Industrial Applications Group. Grand Hotel, Sheffield. Thurs., Nov. 24, 6.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"The Testing of Lubricants and Greases, with Particular Reference to Their Use in the Metallurgical Industry," by H. E. Pristen. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield. Tues., Nov. 22, 7 p.m.

Society of Instrument Technology

CHESTER
"Photography as a Tool," by E. J. Grimwade. Chester Section. 5 King's Buildings, King-street, Chester. Wed., Nov. 23, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Engineer Buyers and Representatives Association, 47 Victoria-street, London, S.W.1. (ABBey 3583.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham, 4. (Midland 6971.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Works Managers, 67-68 Chandos-place, London, W.C.2. (TEMple Bar 8324.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool 2. (Central 3717.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7. (Sheffield 53674.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)

THE HUMAN ELEMENT

News too good to be true.—Jobs too many to be filled.—A union not too immune to be sued by a member.—Unemployment too short to receive benefit.—Comment too clumsy to do good.—Neurosis too common for good health.

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Rumours About Jobs

Many people can remember the remarkable rumours which used to develop in the depressed days of the 1930's about the closing of factories. Businesses died many times before their death and flourishing concerns were not immune from baseless gossip about closing down. It is beginning to look as though there is an inverse set of circumstances to this state of affairs which develops at times of very full employment.

Recently reports appeared that the new B.T.H. factory at Leicester, which is being built at Braunstone aerodrome to make electronic equipment, would employ as many as 2,000 to 3,000 workers. The company has found it necessary to announce that the labour force will be of the order of 350 to 450, of which a proportion will be technicians already in its employment. Eventually the factory will probably employ about 750 people.

Here is an interesting side-line to the problem of full employment. The rumour appears to behave in a very similar way to the kind which appeared over 20 years ago. The exaggeration quickly grows to an absurd size and is worst in the area where it can do the most damage. It would be interesting to know if this kind of rumour is more prevalent in such areas as the Midlands (where this case has arisen), which is suffering severely from a shortage of labour, than in say South Wales or parts of Scotland. It is clearly a factor making for an increased distortion of the labour market. The foolish situation arises where men may move from one area where there is still slight unemployment to another where no jobs exist. Alternatively, the wrong kind of labour gets on the move.

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Not Enough Workers

The shortage of workers is to-day more acute than it has ever been in the country's peace-time history, but it is also what the economists call marginal, and a very narrow margin at that. It was recently put at 2 per cent. of the total working population, or approximately 500,000 "situations vacant." Yet at the end of September there were 270,000 more people in employment than a year previously. Unemployment amounted to 1 per cent. of all employees and probably included a hard core of near-unemployables, who drag themselves from job to job.

Such a situation is conducive to management headaches and ulcers, but it also has its usefulness. To get and keep the employees they need, managements are learning fast to improve personnel relations, and this does not only mean soft treatment, inflated wage scales, and large doses of welfare. By degrees, but latterly more quickly under the leadership of a handful of men, managers are learning the value of mutual understanding and trust based on open dealing and respect. Most of us know at least one case where a firm is not short of workers though it pays less than some of its neighbours. Moreover, the employees of such a firm tend to be willing and keen; and who among managers—or for that matter among trade unionists—would deny that nine men can, if they wish, do the work of ten, in almost any working group? This would make nonsense of a 2 per cent. shortage.

Another aspect of the problem is the considerable impetus given by the shortage of labour to better planning, better methods and more mechanisation. Much has been written about automatic transfer machines and electronic controls, yet most works consultants would agree that simple layout improvements, method study and a more tidy site or factory can shoot up productivity by 10 to 20 per cent. There is abundant proof that this can be done. To some measure, therefore, the shortage of workers is an indictment of management's ability to manage. It is a challenge that is being taken up through sheer necessity. Meanwhile it has given the same kind of impetus to method study and to the adoption of labour-saving machines as the shortage of coal did to the development of atomic power. Industry may yet emerge the stronger for its years of labour shortage.

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Bonsor v. Musicians' Union

This case, on which judgment was given last week by the House of Lords, is a landmark both in the preservation of the rights of the individual and the evolution of trade union law. At the beginning, the husband of the plaintiff who went before the House of Lords (he himself died before the case reached the Court of Appeal, the previous stage before going to the House of Lords) had claimed that he had been wrongfully dismissed, and claimed damages. Eventually the case came before the Court of Appeal who ruled, bound as they were by their own previous decision of 1915, that since the union as such was not an entity recognised by law it could not be sued by one of its members. He would have to sue the members individually. This remarkable position in law arises from the nature of the statutes governing trade unions, by which they enjoy certain unique privileges including immunity from actions for tort.

The man's widow took the case to the House of Lords, with the result that the Court of Appeal's decision was reversed. A union can now be sued for damages by one of its members. The individual can now not only have the courts declare that he is in the right (he could go that far before) but he can get financial redress as well. This is a valuable gain. It is particularly important to have it established in an age when the trade union movement is becoming increasingly controlled, perhaps inevitably, by a complicated hierarchy of officials who may often be tempted to employ methods of petty tyranny. On the other hand, the decision may have important implications for the position of trade unions in law which have still to be established. It is important for the trade union movement that these should be worked out as soon as possible.

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Short-term Unemployment and Sickness Benefit

Further progress has been made with the review of the working of the National Insurance Scheme. Last week, the report was published of the National Insurance Advisory Committee (under the chairmanship of Sir Will Spens) on benefit for short spells of unemployment or sickness.

They recommend that the rules for waiting days should remain the same for unemployment benefit as for sickness benefit and that, for both, the waiting period should be three days as before. One member of the committee, Sir Alfred Roberts, dissents from this. In the case of "guaranteed week" arrangements, where this takes the form of a minimum weekly wage, a worker on short time cannot receive unemployment benefit for the days he does not work. Where the guarantee is for a minimum amount of employment it can be payable for that part of the week not covered by the guarantee. The report considers that eligibility for sick pay from employers' schemes should not be taken into account in deciding entitlement for national insurance sickness benefit.

After lengthy discussion, the committee have decided not to recommend any change in the arrangement by which a five-day-week worker who loses one day's work can receive benefit for that day and also for his usual non-working day if he makes himself available for work on both these days. The committee consider also that where a man changes his job and is thereby obliged to take a second holiday and gets no pay for it, he should not be automatically barred from unemployment benefit, and rules are being submitted in draft to cover this point.

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Ill-timed Arrival

A singularly unimaginative "Final Report on the Working of the London Docks" has been published by the London Chamber of Commerce. On September 28 the Chamber convened a conference "of representatives of 13 organisations whose members were concerned with the import and export trade of the Port, and in the light of the views expressed at that conference the Chamber's final report has been compiled." Admittedly, the report lays no claim to being the result of a systematic investigation of port facilities and working conditions, but being as it is a collection of agreed views it reads like a catalogue of complaints set down in a tone of self-righteous indignation. The resolution that, because at the back of the minds of employees there is the fear of unemployment and of a reversion to the evils of casual labour which prevailed before the war, employers should assure the men and their families that their fears are quite unfounded and so win their confidence, is one of the pearls of wisdom in the report.

There are some recommendations for the restoration of overtime working, for a quicker rate of mechanisation, a more effective control of the flow of goods to the docks, the extension of the practice of staggered loading dates, and for the building of additional dock facilities. No detailed scheme is put forward, however.

The publication of this report, while the official Docks Inquiry Committee is sitting (Human Element, October 21) may have been timed to serve as an *aide-mémoire* for the Committee. It is one of those cases where silence might have made a greater contribution to the solution of a complex problem.

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Mental Health

Sir Walter Monckton, Minister of Labour, and Mr. Ian McLeod, Minister of Health, both spoke last week at the opening of the Mental Health Exhibition at Central Hall, Westminster. This exhibition, to be held in many parts of the country, is designed primarily to help to solve the serious staffing problem in mental hospitals and to give enlightenment to as wide a public as possible on the subject of mental health. Sir Walter expressed his conviction that the main obstacle to recruitment is "lack of knowledge and the fears, often exaggerated and erroneous, to which this ignorance gives rise."

Mr. McLeod gave statistics which suggest that ignorance and fear are getting less: ten years ago 45 per cent. of all admissions to mental hospitals were voluntary patients; the proportion is now 71 per cent. and much higher in some hospitals. There is evidence of a new attitude to mental health problems, which is producing hospitals for the sick rather than asylums for the insane, open wards rather than locked cells, and gaily decorated hospitals in place of the "dark chocolate and dirty green paint" of only a few years ago.

Such progress is very welcome, but there is also evidence that neurosis and unbalance are more common than they were. What Dr. Fromm calls the disease of modern society (Human Element, October 28) has grown faster than the means to treat it. The problem of overcrowding and staffing which Mr. McLeod described as "the most serious and baffling in the National Health Service" may require action more radical than a recruitment campaign.